

University of Dundee

Preventing disease and saving resources

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Preventing disease and saving resources: the potential contribution of increasing breastfeeding rates in the UK



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FOREWORD

Two challenges stand out as we contemplate the future of health services in the United Kingdom. The first is the state of the public finances and therefore the pressure in real terms on health services funding. The second is the recurring and vexing problem of health inequalities. The state of health inequalities in Britain has been commented on by many, but we have seen precious little real change in the disproportionate burden of early death and illness among the most disadvantaged and indeed across the whole health gradient in recent years.

In the light of both these problems, this report makes refreshing reading. The authors present an argument that, in a nutshell, promises to make considerable savings for the health services, produce long run health benefits and is a mechanism for changing the differences in health outcomes across social groups. The idea is, of course, simplicity itself: improving the rates of the initiation and the continuation of breastfeeding. Old fashioned public health, one might suppose; but breastfeeding as this report demonstrates, has profoundly beneficial effects on the lives of infants, children and their mothers, and is an arena where the interests of mothers and babies align with those of the health service and wider society.

The argument that the authors develop is that there are large costs to the health service of treating diseases that are associated with not breastfeeding. The approach is conservative. They press into service what they define as the highest quality evidence and they focus on diseases where the most confidence can be placed in the data. They show that the savings associated with not having to treat gastrointestinal and lower respiratory tract infections, acute otitis media and necrotising enterocolitis in infants would yield considerable cost savings. When a broader view is taken, and cases of breast cancer, Sudden Infant Death Syndrome, poor cognitive development and early years' obesity are included, additional cost savings accrue correspondingly.

The authors use a variety of economic techniques and a very careful review and appraisal of the

evidence to draw their conclusions. They confine their analyses to health service costs. They do not consider broader costs to society. Nor do they deal in detail with the many other health problems that have been linked over the years to not breastfeeding, such as type 2 diabetes, cardiovascular disease, asthma and adult obesity. They do, however, note that if costs beyond the health sector were to be included and if these other conditions could be built into the analyses, then the cost savings would be very significant indeed.

Using one local area as the basis for illustrating the costs of taking a proactive approach to addressing low breastfeeding rates, they are able to show what the costs of such an intervention would be and how quickly the savings would appear on the balance sheet.

This is an important report in several ways. It is important scientifically – the methods used are at once rigorous and novel. It is important practically – it shows what can be done to make matters better. And it is important for policy – it shows in stark relief what the nature of the problem is but also presents the potential solutions.



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Preventing disease and saving resources: the potential contribution of increasing breastfeeding rates in the UK

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GLOSSARY

acute otitis media (AOM)	middle ear infection
any breastfeeding	Infant receives some breastmilk: either only breastmilk (see exclusive breastfeeding) or breastmilk and other substances (see mixed feeding, partial breastfeeding, complementary feeding). Any breastfeeding is used to describe the feeding of a group of infants who received different amounts of breastmilk, or when the amount of breastmilk they were fed is not known.
artificial feeding	Infant is fed only on a breastmilk substitute (World Health Organization, 2003). <i>See</i> breastmilk substitutes; formula.
Baby Friendly Awards	The Baby Friendly Initiative of UNICEF UK accredits, through a staged assessment process, maternity and community facilities that adopt internationally recognised standards of best practice in the care of mothers and babies.
Baby Friendly Initiative	Worldwide programme of the World Health Organization and UNICEF to encourage maternity hospitals to implement the 10 Steps to Successful Breastfeeding and to practise in accordance with the International Code of Marketing of Breast-milk Substitutes.
base case models	Models that normally include the best assumptions and data estimates in the analysis.
breastmilk substitutes	Any food being marketed or otherwise represented as a partial or total replacement for breastmilk, whether or not it is suitable for that purpose (World Health Organization, 2003).
lower respiratory tract infection (LRTI)	bronchiolitis or pneumonia
cardiovascular disease	Disease of the heart and blood vessels usually manifesting as high blood pressure, heart attack and stroke
chronological age	Time since the infant's birth (Engle and American Academy of Pediatrics, 2004). <i>See also</i> corrected age; gestational age; postmenstrual age.
coeliac disease	Inflammation of the gut cause by an immune reaction to gluten (a wheat protein)
comparator	Circumstance with which the subject intervention is compared.
complementary feeding	Child receives both breastmilk and solid (semi-solid or soft) foods. It is not recommended to provide any solid, semi-solid or soft foods to children less than six months of age (World Health Organization, 2003). <i>See</i> any breastfeeding; exclusive breastfeeding, mixed feeding; partial breastfeeding.
corrected age	Chronological age reduced by the number of weeks born before 40 weeks of gestation. The term applies to children up to 3 years old who were born preterm (Engle and American Academy of Pediatrics, 2004). <i>See</i> chronological age; preterm birth.
cost-of-illness study	Specific type of analysis that aims to measure the economic burden of a disease or diseases. Such studies can help to estimate the potential savings if a disease were to be prevented or eradicated.
enteral feeding	Administration of any feed into the gastrointestinal tract.
exclusive breastfeeding	Infant receives only breastmilk (including breastmilk that has been expressed or from a wet nurse) and nothing else, except for medicines, vitamins and minerals, oral rehydration salts (World Health Organization, 2003).
formula	Artificial milks for babies made out of a variety of products including sugar, animal milks, soya beans, and vegetable oils. They are usually in powder form to mix with water (World Health Organization, 2003). Currently, in Europe, formula is modified from cow's or soya milk and manufactured according to compositional standards prescribed in the European Directive or Codex Alimentarius. <i>See</i> preterm formula.
fortified feeds, fortifiers	Addition of protein, vitamins and minerals to breastmilk with the aim of meeting preterm infants' specific nutritional needs.

gastroenteritis, gastrointestinal infection (GI)	diarrhoea and vomiting attributable to infection
gavage feeds	Introduction of food into the stomach by means of a tube inserted through the mouth (orogastric) or the nose (nasogastric).
gestational age	Time between the first day of the mother's last menstrual period and the infant's birth (Engle and American Academy of Pediatrics, 2004). <i>See also</i> chronological age; postmenstrual age.
incidence	Proportion of new cases of a condition occurring within a certain period. For example, the number of mothers who initiate breastfeeding.
industrialised setting	Country or region, generally located in the northern or western hemisphere, whose economy is based on industry (Natural Resources Defence Council). This level of economic development usually translates into a high income per capita and a high Human Development Index (HDI) for populations within that country or region.
intention to treat	Outcome is analysed by participants' original treatment allocation, whether or not they completed the study.
International Code of Marketing of Breast-milk Substitutes	Code restricting the marketing of breast-milk substitutes to the public and health professionals. The Code was ratified by the World Health Assembly in 1981, and incorporates subsequent World Health Assembly resolutions. It has been wholly or partly implemented as national law in several countries.
low birth-weight infant	Infant with birth weight less than 2,500g.
milk bank	Service that screens donors, collects, processes, stores and distributes donated breastmilk.
mixed feeding	Infant receives both breastmilk and any other food or liquid including water, non-human milk and formula before 6 months of age (World Health Organization, 2003). <i>See</i> any breastfeeding; complementary feeding; exclusive breastfeeding; partial breastfeeding.
multiples	Infants who are the product of triplet, quadruplet (or more) pregnancy.
mx value	<i>mx</i> is the central rate of mortality, defined as the number of deaths at age <i>x</i> last birthday in the three year period to which the Interim Life Table relates divided by the average population at that age over the same period. Source: Government Actuary's Department, available at: http://bit.ly/SY4nc5 (accessed 28 May 2012).
nasogastric feeding	Administration of feeds into the stomach via a tube passed through the nose.
necrotising enterocolitis (NEC)	serious inflammatory condition of the gut in newborn babies, usually those prematurely born
neonatal sepsis	infection of the newborn caused by bacteria in the bloodstream
oral feeding	Administration of any feed into the mouth.
orogastric feeds	Administration of feeds into the stomach via a tube passed through the mouth.
parenteral feeding	Intravenous provision of fluid and nutrients when infants are unable to receive their whole dietary requirements enterally.
parous	Woman who has given birth to one or more children
partial breastfeeding	One of several terms for breastfeeding that is not exclusive. <i>See</i> any breastfeeding; complementary feeding; exclusive breastfeeding; mixed feeding).
population attributable fractions (PAF)	Used for exposures that result in an increased risk of disease (for example, smoking) rather than a protective effect (for example, breastfeeding). <i>See also</i> preventive fractions.
postmenstrual age	Gestational age plus chronological age (Engle and American Academy of Pediatrics, 2004) <i>See also</i> chronological age; gestational age.

GLOSSARY (continued)

post-term birth	Birth occurring after 42 completed weeks of gestational age.
prevalence	The proportion of cases of a condition among the population at risk. For example, the proportion of mothers who are breastfeeding at a particular point in time.
preterm birth	Birth occurring before 37 weeks of gestational age.
preterm formula	Modified cow's or soy milk manufactured to Codex Alimentarius standards and endeavouring to meet the specific nutritional requirements of preterm infants.
preterm infant	Infant born before 37 weeks of gestational age.
preventive fractions (PF)	Preventive fractions allow incorporation of exposures, such as breastfeeding, that have several categories and a protective effect. See population attributable fractions.
primiparous	Woman who has given birth to only one child
QALYs	Acronym for Quality Adjusted Life Year. QALY is a measure of health outcome that takes into account both quantity and quality of life lived. One QALY is said to be gained if a medical or health-care intervention leads an individual to live one extra year in full health.
SCBU	Special Care Baby Unit
sensitivity	Technique that handles several types of uncertainty associated with economic analysis by determining which input parameters are the key drivers of an economic model's conclusions.
stable infant	Infant who has adapted successfully to extrauterine life and does not require continuous medical monitoring or supportive intervention.
term birth	Birth occurring between 37 and 42 completed weeks of gestational age.
very low birth-weight infant	Infant with birth weight less than 1,500g.

KEY MESSAGES

- ❖ Low breastfeeding rates in the UK lead to an increased incidence of illness that has a significant cost to the health service.
- ❖ Investment in effective services to increase and sustain breastfeeding rates is likely to provide a return within a few years, possibly as little as one year.
- ❖ Investing in supporting women to breastfeed will improve the quality of life for women through the reduction in incidence of breast cancer; and for children through reducing acute and chronic diseases.
- ❖ Research into the extent of the burden of disease associated with low breastfeeding rates is hampered by data collection methods; this can be addressed by investment in good quality research.

EXECUTIVE SUMMARY

This study aims to fill a gap of rigorous research relating specifically to the UK that could answer whether increasing the prevalence of breastfeeding will translate into significant cost savings.

UNICEF UK commissioned this report to better understand the potential contribution that increasing breastfeeding rates would make to preventing disease and saving resources. **This report shows that investment to increase and sustain breastfeeding rates will provide a rapid financial return on investment.**

The UNICEF UK Baby Friendly Initiative was introduced 16 years ago to bring UK health services up to a minimum standard in their support of breastfeeding. At that time, the UK had one of the world's most entrenched bottle-feeding cultures and consequently one of the lowest breastfeeding rates. While there have been increases in the proportion of mothers initiating breastfeeding, discontinuation of breastfeeding in the days and weeks after birth continues to be a major concern. **Low breastfeeding rates in the UK lead to an increased incidence of illness that has a significant cost to the health service.**

The strong evidence of the health risks associated with *not* breastfeeding makes this a major public health issue that requires investment and an organised and informed response. **Investment in supporting women to breastfeed will improve the quality of life for women and for children through reducing acute and chronic diseases.**

We know that the overwhelming majority of mothers who breastfeed stop before they want to, and so UNICEF UK is calling for leadership and investment in order to remove the barriers that prevent women from successfully breastfeeding for as long as they choose.

Aims

Increased awareness of the health risks associated with *not* breastfeeding has brought about a drive in recent years to improve breastfeeding support and increase breastfeeding prevalence in the UK, where breastfeeding rates have been among the lowest in the world for many decades. Governments have encouraged improvement of breastfeeding support by funding maternity hospitals and community settings to engage in a number of national and local strategies including the UNICEF UK Baby Friendly Initiative.

There is an underlying policy assumption that increasing the prevalence of breastfeeding will translate into significant cost savings for the health-care system. However, there is still a lack of rigorous research relating to the UK. This study aims to fill that gap.

Methods

A series of reviews identified studies that could quantify

- a) the risk of increased disease linked to not breastfeeding and
- b) the cost of illness related to low breastfeeding rates in the UK.

For each disease or condition, realistic, achievable scenarios for potential increases in breastfeeding rates were developed. To illustrate how the findings could be used to inform policy and practice, the study examines the costs that could be saved in an area of the UK that has a clearly defined, evidence based, infant feeding strategy.

Because it is seldom possible to conduct randomised controlled trials in this field, analysis relies mainly on observational data. It is therefore important to recognise and control for confounding variables – such as socio-economic background, or other systematic differences between women who breastfeed and those who do not – to avoid *overestimating* the scale of the differences between groups. However, as women in the UK and other developed countries often breastfeed for a short time, or mix feeding methods, few studies have been able to examine the impact of breastfeeding exclusively for the first six months of life. This may result in differences between groups being *underestimated*.

In this study we have adopted a methodological approach that is both systematic and transparent, taking care not to overestimate or underestimate the burden of disease or the costs resulting from not breastfeeding. **To avoid the risk of overestimation of costs, however, we consistently erred on the side of conservative assumptions when making methodological decisions.**

Our quantitative economic models are based on best quality evidence, relevant to the UK, where we could provide a reliable estimate of effect size, and therefore the economic impact. As so many other outcomes do not have evidence in the form required for economic modelling and as we have only included costs to the health sector, these estimates are likely to be a minimum estimate of the economic consequences of the current low rates of breastfeeding in the UK. **The true scale of the impact of breastfeeding is likely to be much greater.**



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Results

Four categories of reviews and studies were identified:

Category 1

A total of 25 systematic reviews and UK studies provided robust evidence for economic analysis. We developed **quantitative models** for five outcomes:

- four acute conditions in infants: gastrointestinal disease, respiratory disease, otitis media, and necrotising enterocolitis (NEC)
- breast cancer in mothers.

Quantitative models found that:

Assuming a moderate increase in breastfeeding rates, if 45% of women exclusively breastfed for four months, and if 75% of babies in neonatal units were breastfed at discharge, **every year** there could be an estimated:

- 3,285 fewer gastrointestinal infection-related hospital admissions and 10,637 fewer GP consultations, with over £3.6 million saved in treatment costs annually
- 5,916 fewer lower respiratory tract infection-related hospital admissions and 22,248 fewer GP consultations, with around £6.7 million saved in treatment costs annually
- 21,045 fewer acute otitis media (AOM) related GP consultations, with over £750,000 saved in treatment costs annually
- 361 fewer cases of NEC, with over £6 million saved in treatment costs annually.

In total, **over £17 million could be gained annually by avoiding the costs of treating four acute diseases in infants.** Increasing breastfeeding prevalence further would result in even greater cost savings.

If half those mothers who currently do not breastfeed were to breastfeed for up to 18 months in their lifetime, for each annual cohort of around 313,000 first-time mothers there could be:

- 865 fewer breast cancer cases
- with cost savings to the health service of over £21 million
- 512 breast cancer-related quality adjusted life years (QALYs) would be gained, equating to a value of over £10 million.

This could result in an **incremental benefit of more than £31 million, over the lifetime of each annual cohort of first-time mothers.**

Category 2

Evidence on three outcomes was identified where limitations of the current evidence base means that the scale and scope of the economic impact was difficult to measure with precision. For these, the evidence was adequate to provide **narrative analyses** to indicate the scale and scope of the costs to the health service and beyond. The outcomes examined were: cognitive outcomes, early years obesity, and Sudden Infant Death Syndrome (SIDS)

Narrative analyses found that:

- if just 1% of those who currently “never breastfed” were to initiate breastfeeding, it could be associated with a small increase in average IQ that in turn could result in over £278 million gains in economic productivity over the lifetime of each annual birth cohort.
- a very modest increase in the rates of exclusive breastfeeding could be associated with the avoidance of at least three cases of SIDS annually, averting the profound consequences for families and avoiding an annual monetary loss of around £4.7 million and a loss of £1.3 million annually in QALYs.
- increasing breastfeeding rates to a level compatible with reducing the rates of early years obesity by as little as 5%, would result in reducing annual health-care expenditures by more than £1.6 million.

The nature of these conditions, and the limitations of the current evidence base, mean that the scale and scope of the economic impact is difficult to measure with precision. It is evident that it is likely to be very wide ranging and significant. The work on these topics, together with the other chronic diseases identified, informs an important research agenda.

Category 3

We identified a further eight outcomes where it is plausible that the outcome is related to infant feeding, but where the strength of evidence, or where the way in which outcomes or infant feeding had been measured, is inadequate to inform an economic analysis. These include chronic diseases in both the mother and infant that are very costly to the health service. This list demonstrates the potential extent of the economic consequences of not breastfeeding in the UK, which is likely to be much greater than the quantitative models we have been able to develop. It also acts as a research agenda for future studies of the costs of disease and developmental outcomes. The outcomes identified were:

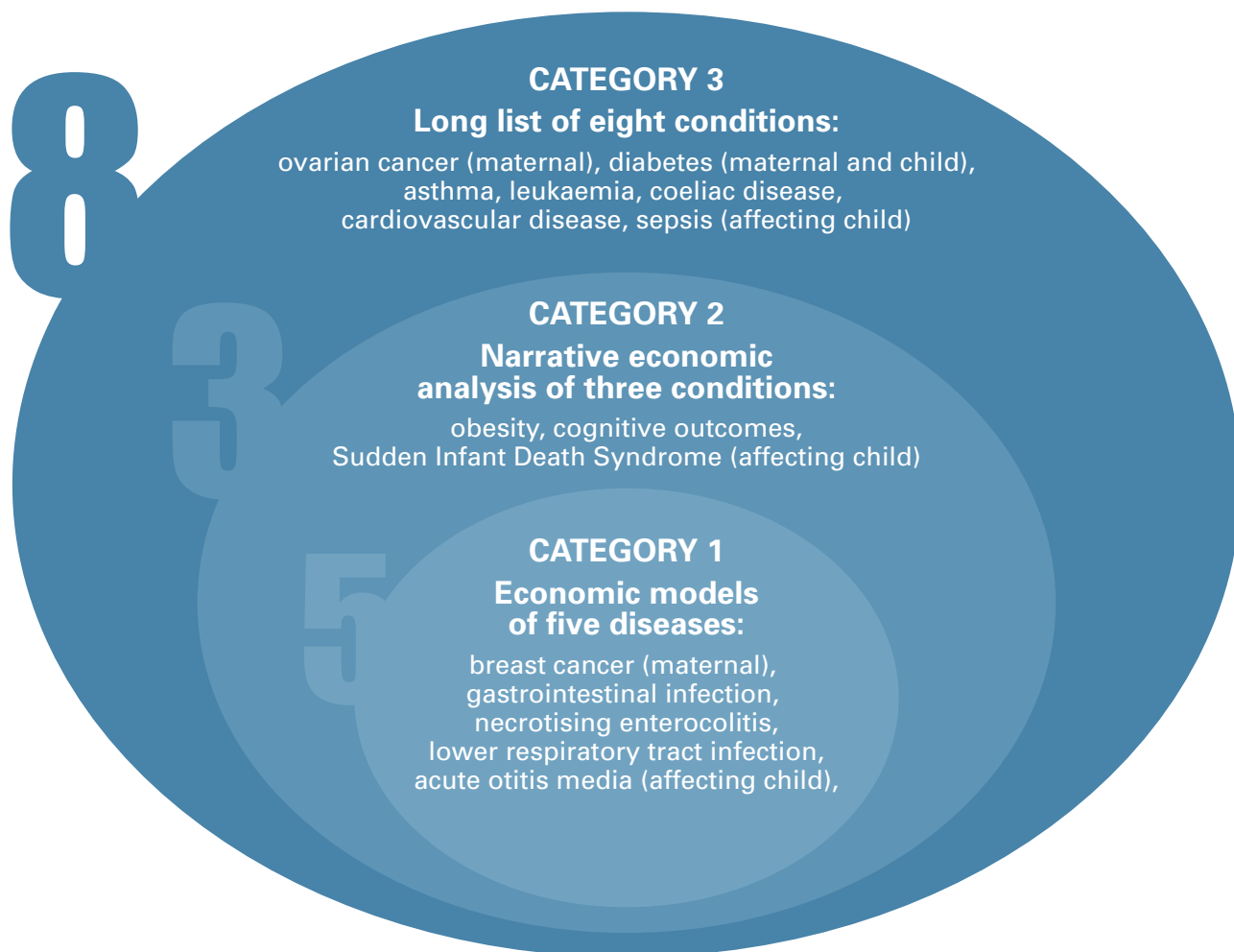
- Ovarian cancer and Type 2 diabetes in the mother
- Asthma, diabetes, leukaemia, coeliac disease, cardiovascular disease, and sepsis in the child.

Category 4

A further 45 outcomes were identified where there is some evidence of association with not breastfeeding. These form an agenda for future research, therefore these outcomes are not shown in Figure 1

Figure 1

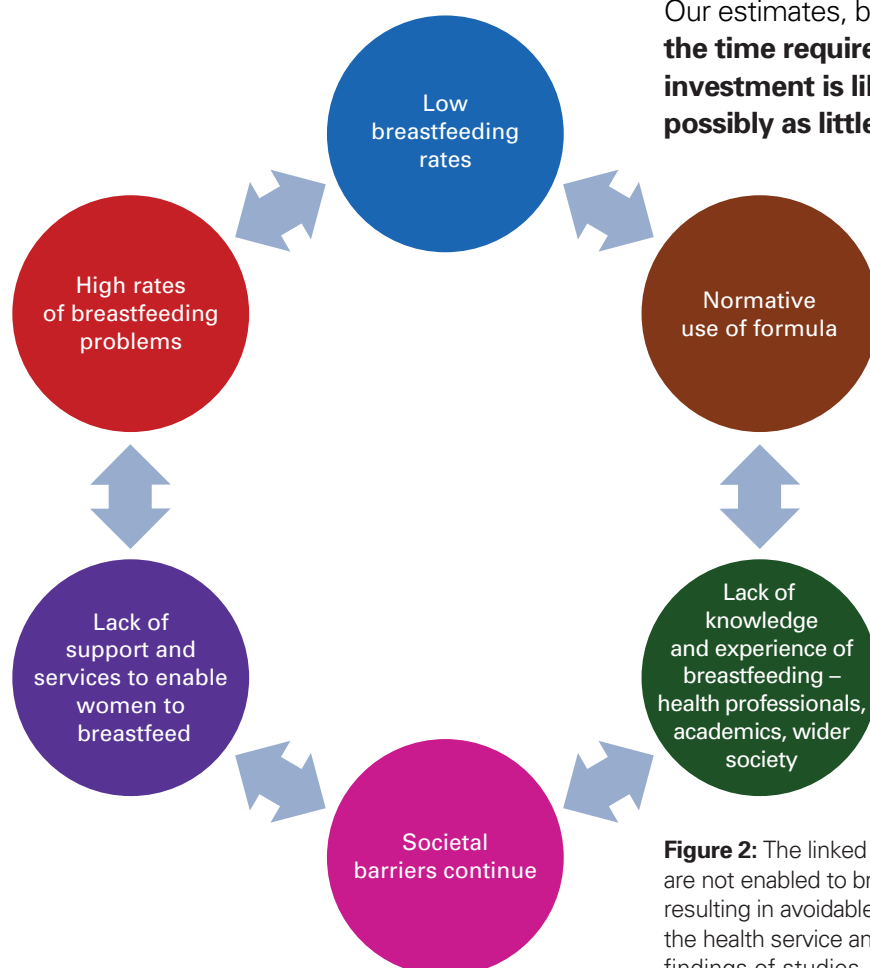
Diagrammatic representation of the costs resulting from disease and developmental deficit resulting from low rates of breastfeeding in the UK (illustrative, not representative). Conceptually the costs estimated in section 4 are likely to be a small sub-set of the real NHS costs associated with low breastfeeding rates.



Investing in enabling women to breastfeed

Because breastfeeding rates in the UK have been so low for so long, health service and community support for breastfeeding is not consistent. To break the cycle of linked factors that make breastfeeding difficult for women in the UK (illustrated below, Figure 2), changes are needed to address the societal, family and health service barriers to breastfeeding.

Changes to address the societal, family and health service barriers to breastfeeding are needed to break the cycle of linked factors that make breastfeeding difficult for women in the UK.



From a health service perspective, increasing breastfeeding rates will require resources to be invested in services. To understand the full economic picture, the cost needed for support services should be set against the costs saved from preventing disease. Using one English region as an example, we illustrated the cost of implementing an evidence-based, multifaceted programme that would build on priority national recommendations. Within any UK locality of similar size, population base, and current breastfeeding rates, such a programme would cost around £446,300 in its first year with a recurring annual cost of around £329,300.

The time taken to realise the investment will depend on the rate at which breastfeeding initiation, duration and exclusivity increase, which in turn will depend both on factors in the local population and on the extent and quality of services to support breastfeeding women. The diseases studied here have shown a dose-response effect that means that even a small increase is likely to result in some savings.

Our estimates, based on our analyses, suggest that **the time required to show a positive return on investment is likely to be within a few years and possibly as little as one year.**

Figure 2: The linked factors that exist when women are not enabled to breastfeed for as long as they wish, resulting in avoidable burden of disease and costs to the health service and wider economy. (Derived from findings of studies, including Dyson et al, 2006.)

Conclusions and recommendations

Enabling women to breastfeed for as long as they choose to is a health issue where the interests of the mother, baby and the health services all align. This study shows that the more common breastfeeding becomes, particularly exclusive and continued breastfeeding, the higher the cost savings to the health service will be. Despite the conservative approach we have taken, it should reassure policymakers, service planners and commissioners that investment in effective services to support women to breastfeed is likely to produce a return on investment within a few years, possibly as little as one year.

Investing in public health interventions, particularly at a time when funds are scarce, is challenging, as many of the potential financial savings accrue in the distant future. **However, as shown in this report, many of the potential savings from breastfeeding support are likely to be realised over a much shorter time horizon.** At a time when healthcare investments need to show a near-term return on investment, this is an important consideration.

Research is needed to extend our knowledge of the impact of infant feeding on health. This would improve the modelling and analyses we have undertaken. **Most importantly, long-term prospective cohort studies should be established specifically to examine these issues.** These should use accurate measurement of different infant feeding methods. We identified a priority list of eight further, mainly chronic, diseases where data exist, but not yet in a form that permits economic modelling. **Until adequate data on these conditions are available, the potential for breastfeeding to reduce the distress and expense associated with chronic diseases cannot be fully measured.**

There are social, educational, family and wider economic costs to low breastfeeding rates that are not considered in this report. However the findings signal a need for society to debate infant feeding more widely; its economic consequences, its role in child health, child development, maternal health, family life and relationships.

Harrow case study

Harrow Community Services and Northwick Park Hospital are examples of where joint investment in support services for women has translated into higher breastfeeding rates and reduced illness in babies. Work towards the UNICEF UK Baby Friendly Standards started in 2005, when the breastfeeding initiation rate was 67% and only 33% of mothers were still exclusively breastfeeding at 6–8 weeks. Multidisciplinary training was rolled out for midwives, health visitors and GPs across the acute trust and community services, so that women experienced a joined-up consistent level of care. A widespread network of trained peer supporters has been set up who work with mothers in hospital and in the community and run breastfeeding support groups on every weekday. Harrow now has a breastfeeding helpline, website, Facebook page and Twitter site, all run by peer supporters.

In 2012, 90% of mothers are initiating breastfeeding and 50% of mothers exclusively breastfeed at 6–8 weeks. Along with some other London boroughs, Harrow is seeing a reduction of children less than 1-year-old being admitted to hospital with gastroenteritis, and these

rates are 16% lower than the current UK average for health authorities. Breastfeeding is becoming the normal way to feed babies in Harrow.



1 BACKGROUND AND CONTEXT

Increased awareness of the health risks associated with *not* breastfeeding has brought about a drive in recent years to improve breastfeeding support and increase breastfeeding prevalence rates in the UK. Targets have been set and financial support offered to UK health services to implement the Baby Friendly Initiative and other strategies.

There is an underlying policy assumption that increasing the prevalence of breastfeeding will translate into significant cost savings for the health-care system. However, there is still a lack of rigorous evidence relating to the health services within the UK. The purpose of this study is to fill this gap by determining if there would be any savings, and if so, how much and over what time span.

The economic impact of infant feeding is extensive and multi-faceted. Studies in the USA, Australia, and the Netherlands have shown that large-scale savings to their national economies would result from raising breastfeeding rates. The costs of *not* breastfeeding include health service costs such as treating a range of related diseases affecting mothers and children, and costs to families such as the cost of purchasing infant formula (Bartick and Reinhold, 2010; Weimer, 2001; Smith et al, 2002; Drane, 1997; Ball and Wright, 1999; Buchner et al, 2007). Breastfeeding women make a substantive, direct and positive contribution to the national economy through the production and supply of breastmilk (Smith, 1999).

In countries with low breastfeeding prevalence, realising the savings that would result from increasing breastfeeding rates will require an investment in promotion and support programmes to enable more women to breastfeed. When examining the costs to the health service, the balance between savings and costs need to be considered.

Differences in social, political and economic contexts between the UK and the countries in which previous studies have been conducted raise questions about the scale of expected cost savings in the UK. For example, rates of exclusive breastfeeding and the duration of any breastfeeding have been very low for many years (Bolling et al, 2007), and women report

a range of problems with breastfeeding, including problems of breastfeeding in public, that make continuing to breastfeed particularly challenging in the UK (Dyson et al, 2010a; Lee, 2007). It is especially important for policymakers to have access to UK data based on up-to-date information to inform service planning, commissioning and policy decisions.

This study addresses the question: what is the potential contribution of increasing breastfeeding rates to preventing disease and saving resources in the UK?

1.1 Why infant feeding matters

There is good quality evidence quantifying the short-term and long-term health risks of *not* breastfeeding for both infants and their mothers. *Not* breastfeeding has important adverse effects across all income bands. Breastfeeding provides complete food and nutrition by responding to the needs of the individual infant through the day and over time, and it provides active immunity to disease tailored to each baby's individual circumstances (Hanson, 2004). Good quality studies of conditions such as gastroenteritis, respiratory disease, SIDS, and otitis media for infants, and breast cancer for mothers, have shown that all of these conditions are more prevalent when infants are not breastfed (Howie et al, 1990; Wilson et al, 1998; Ip et al, 2007; Horta et al, 2007; Quigley et al, 2007a; Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002). Recent studies have shown an increased risk of poorer cognitive development and behavioural problems in children who were not breastfed (Heikkilä et al, 2011; Quigley et al, 2011; Kramer et al, 2008).

There are inherent differences between breastmilk and the substitutes used to replace breastfeeding (such as infant formula, water, fruit juice or solid foods).

- Infant formula marketed in the UK meets international nutritional standards but its composition differs substantially from breastmilk. Its ingredients vary between manufacturers, it does not confer immunity,

nor does it promote neurological development as breastmilk does (Michaelsen et al, 2009), it has no direct impact on maternal health, and it requires manufacturing, storage and delivery systems with inherent quality control problems (McNiel et al, 2010; European Food Safety Authority (EFSA) Scientific Panel on Biological Hazards, 2004).

- The premature introduction of solid foods to the baby can result in health problems including increased respiratory infections (Wilson et al, 1998), and both fluids and solids displace breastmilk in the baby's diet (Kramer and Kakuma, 2002).

Recognising these inherent differences and the resultant impact of breastmilk substitutes on short and long-term health, international public health recommendations have been agreed. These state that, with the exception of specific health circumstances where breastfeeding is contra-indicated, infants in all settings should be exclusively breastfed until six months of age, and that breastfeeding should continue, along with appropriate solid foods and fluids, until at least two years of age (WHO, 2003). These recommendations have been endorsed by the UK health departments.

1.2 Rates of breastfeeding and formula feeding

Around 81 % of new mothers in the UK start to breastfeed (Information Centre for Health and Social Care, 2011). There has been a steady increase in this proportion in all four countries since 1990, when around 62 % of women in the UK initiated breastfeeding (Hamlyn et al, 2002). It is likely that this trend is a consequence of increased public and professional awareness of the impact of infant feeding on health, and of public health policy developments in all four countries (UNICEF UK BFI, 2001; Department of Health, 2007; National Institute for Health and Clinical Excellence, 2008 updated 2011; Department of Health, 2009; The Scottish Government, 2011; Department of Health, 1995; Northern Ireland Breastfeeding Strategy Group, 1999; SACN/RCPCH Expert Group on Growth Standards, 2007).

However, the proportion of women still breastfeeding at six weeks after birth increased by only a few percentage points between 2000 and 2005 – to just under 50% (Bolling et al, 2007). Rates of exclusive breastfeeding are much lower – only 45% of women reported that they were breastfeeding exclusively at one week after birth; fewer than 1 % were still doing so at six months (Bolling et al, 2007). The rapid discontinuation of breastfeeding in the early days and weeks after birth, seen consistently since national surveys began in 1975, has only marginally improved to date, demonstrating that women who start to breastfeed often

90% of women who stop breastfeeding in the first six weeks report that they discontinue breastfeeding before they want to

encounter problems, whether socio-cultural or clinical in nature, and stop. Ninety per cent of women who stop breastfeeding in the first six weeks report that they discontinue breastfeeding before they want to (Bolling et al, 2007). As a consequence, women can feel that they have failed their babies (Lee, 2007), and the great majority of babies in the UK are fed with formula in full or in part at some time during the first six months of life, and by five months of age, 75% of babies in the UK receive no breastmilk at all.

1.3 Infant feeding and inequalities

The babies most likely to be breastfed are those from families living in relatively affluent circumstances and with well-educated parents, or families from minority ethnic backgrounds (Kelly and Watt, 2005; Bolling et al, 2007; Brown et al, 2010). Babies of parents from low-income backgrounds, who are young, white, with fewer educational qualifications and who were themselves formula fed, are least likely to be breastfed. This is an intergenerational problem: women are likely to follow the infant feeding patterns of their mothers. In some low-income communities, formula feeding is endemic and breastfeeding is rarely seen, making a fundamental contribution to inequalities in health (Nelson, 2000). Thus not being breastfed is both a consequence **and a cause** of social inequalities, since babies who are not breastfed are more likely to develop ill health. Promoting breastfeeding,

protecting families and health professionals from advertising about breastmilk substitutes, and supporting women to breastfeed, are among the most effective early years strategies intended to improve health and tackle inequalities (Field, 2010; Marmot, 2010; Wilson et al, 1998). This has been recognised internationally in the adoption of the International Code on the Marketing of Breast-milk substitutes (WHO, 1981), the development of a Global Strategy for Infant and Young Child Feeding (WHO, 2003), the adoption of an EU Blueprint for action on the protection, promotion and support for breastfeeding in Europe (EU Project on Promotion of Breastfeeding in Europe, 2008), and recently by the inclusion of breastfeeding in the Public Health Outcomes Framework for England (Department of Health, 2012).

1.4 Factors influencing infant feeding patterns in the UK

Breastfeeding rates in the UK fell sharply throughout the first half of the 20th century, from the virtually universal breastfeeding seen up to the late 19th century (Fildes, 1986) and reaching very low levels in the 1960s and 70s. The first national infant feeding survey conducted in England and Wales in 1975 found that 51% of women started to breastfeed (Martin, 1978). The social changes that accompanied this decline mean that families today encounter numerous challenges if they consider breastfeeding.

There is often an unsympathetic public attitude to breastfeeding outside of the home, an acceptance of formula feeding as a normal and safe way to feed babies, a lack of expertise and experience of breastfeeding among health service staff and, in many communities, a dearth of practical experience of breastfeeding among grandparents who might be expected to support and inform new parents about aspects of infant care (Renfrew, 2006; Dyson et al, 2010a; McMillan et al, 2009; Dykes, 2006). Breastfeeding is often the subject of contentious

Victoria and Amelie

Victoria has both good and bad experiences of breastfeeding care when she had her baby Amelie in early 2012. *"In the hospital, I had to push to be let to have skin to skin contact and to have assistance with feeding. The postnatal ward was very full and I had a C-section, so I had to buzz to get someone to lift Amelie so I could feed her: only to be told 'Oh, she doesn't need feeding'."*

The locally run breastfeeding clinic had great support and advice

"My daughter went from 8lb to 7lb 2oz in 5 days and led to me having significant worries about her weight for months to come and I nearly stopped breastfeeding due to the lack of assistance and advice."

"The locally run breastfeeding clinic had great support and advice but I found it difficult to access in the first few weeks due to having a C-section and not being mobile. However, I also had some amazing nursery nurses and midwives to help. It really was the luck of the draw."



discourse in both public and professional forums (Martyn, 2011; Rumbelow, 2009). It is commonly associated with images of sexuality, or of feeding difficulties, rather than being seen as a normal, unremarkable, and fundamental aspect of parenting (Henderson et al, 2000). As a result, when women encounter serious but preventable problems with breastfeeding (such as embarrassment and isolation when breastfeeding in public, painful breasts and nipples as a result of not understanding how to effectively attach the baby to the breast, and anxiety about their milk supply), they may struggle to find appropriate care and support. This may lead to their families, friends, and health professionals advocating that they solve the problem by using formula instead (Dykes, 2006). Women's choice to start or to continue to breastfeed is therefore constrained by the culture and community in which they live.

An important economic consequence is that without an adequate environment and support services to enable breastfeeding, women will experience high rates of preventable problems that will be:

- an avoidable burden to the health services
- the cause of premature discontinuation of breastfeeding: 90% of women who discontinue breastfeeding report that they do so before they want to (Bolling et al, 2007)
- substantial family concern and distress.

1.5 Enabling women to breastfeed

Ways of supporting and enabling women to breastfeed in this context have been identified, and many are now included in national strategy and guidance (for example, Renfrew et al, 2012, Dyson et al, 2008; National Institute for Health and Clinical Excellence, 2008 updated 2011; UNICEF UK BFI, 2012; Department of Health, 2009). But implementation of these interventions remains inconsistent, even in communities where breastfeeding rates are lowest and the need for such action is arguably highest (Dyson et al, 2012).

The complex mix of socio-economic, clinical and health service challenges requires a strategic, coordinated, multifaceted approach if rates of

breastfeeding duration, especially the duration of exclusive breastfeeding, are to increase (Dyson et al, 2006). Developments in UK policy to address these challenges have already led to greater numbers of women starting to breastfeed (Information Centre for Health and Social Care, 2011). It is essential that more women are supported to breastfeed and enabled to continue in order to avoid feeding problems, distress, disappointment, and possibly the premature introduction of breastmilk substitutes – all of which are likely to contribute to the perpetuation of the idea that it is difficult to breastfeed. This will require resources for staff training, service provision, and for dissemination of information and evidence to the wider public. An economic perspective is essential to provide policymakers and service commissioners with information to use in decision-making about spending priorities, especially in times of severe resource constraints.

An economic perspective is essential to provide policymakers and service commissioners with information to use in decision-making about spending priorities, especially in times of severe resource constraints.

The economics of infant feeding

To understand the economic consequences of infant feeding, two forms of economic evidence are needed: first, evidence of the scale of the cost of low breastfeeding rates in relation to the consequences for health and related outcomes; second, evidence on the cost-effectiveness of the range of interventions needed to promote and protect breastfeeding, and to support women to breastfeed. These then need to be considered in the light of local and national circumstances.

The main focus of this study is the health service costs incurred as a result of treating diseases resulting from *not* breastfeeding, including costs in both primary and secondary care. There are other economic considerations, such as the economic consequences outside of the health sector: for instance, education and the wider economy. The costs of enabling women to breastfeed include both direct costs to the health service such as staff training and offering support, and costs to society.

From an economic perspective, the costs of treating disease should therefore be balanced against the health service costs and other actions needed to promote and support breastfeeding as well the value of health benefits. This is considered further in Section 5 of this report.

The precise balance of costs saved and incurred through changing infant feeding patterns will be different across countries and communities. For example, in the USA there is very limited maternity leave, so women who take time off work to be with their babies will incur significant loss of earnings (Rippeyoung and Noonan, 2012). The effect on women's earnings in the UK, where maternity leave has increased significantly in recent years, will be much less. In Norway and Sweden, where the great majority of women breastfeed, cultural norms are such that women can breastfeed in public without fear of harassment, and children learn about and understand breastfeeding, so actions to address these issues are not needed as they are in the UK (Lande et al, 2003; Akerstrom et al, 2007).

It is difficult therefore to generalise about the economic consequences of infant feeding patterns across countries.

The implications will also vary across communities within countries. For example, breastfeeding rates vary widely across the UK, related to socio-economic status, ethnicity, and age (Bolling et al, 2007, Child and Maternal Health Observatory, 2012). Initiation rates in primary care trusts (PCTs) in England vary from 42.5% to 92.5% and rates of any breastfeeding at 6–8 weeks range from 19.4% to 83.2% (ChiMat Data Atlas, 30 August 2012 <http://bit.ly/Ry4k39>). Some more affluent communities, or communities with high representation of minority ethnic groups, are likely to require fewer actions to increase breastfeeding rates than low-income communities with lower rates of initiation and duration. Interpreting the findings of this study for different UK communities will therefore require an analysis of the actions needed to address the specific circumstances of the local population.

2 AIM AND OBJECTIVES OF THE STUDY

The overarching aim of this study was to provide decision-makers with evidence from a UK health service perspective on the economic consequences of diseases and conditions preventable by breastfeeding. Specifically, this study examined the potential contribution of increasing breastfeeding rates to preventing disease and saving resources in the context of the UK.

To achieve the aim of the study, we have examined whether cost savings to the health service would accrue as a result of increased rates of exclusive and partial breastfeeding. Short, medium and longer term disease outcomes for both mother and infant have been examined, and outcomes for both healthy infants and those in neonatal units have been included. The study used evidence derived from epidemiological studies, economic modelling, and a narrative economic analysis where modelling was not appropriate. We have used a systematic approach at all stages to ensure that we used the best available evidence, and we have been transparent about our decisions at each stage.

Increasing rates of initiation, duration and exclusivity of breastfeeding will only be achieved by investing in promotion and protection of breastfeeding, and support for women (NICE, 2008). In Section 5.3, we have provided an illustrative example of the cost of implementing a multifaceted programme of evidence-based change in one region, to help to contextualise the findings for decision-makers at local and national levels.

Examining the economic consequences to the health service is an essential first step in measuring the economic impact of infant feeding patterns in the UK. The full economic impact is likely to reach well beyond the health service to include education, employment and other related sectors. This has been considered briefly, as part of three narrative analyses, to illustrate the potential scale of the economic impact of low breastfeeding rates.

The wide range of different economic consequences of infant feeding patterns to society, government and community, and to the mother, baby and family, is considered in Section 5.5 of this report.

The study was conducted by a multidisciplinary team with expertise in systematic reviews, statistics and epidemiology, health economics, health policy, and infant feeding. Team members had clinical backgrounds in neonatology and midwifery, and one team member was a service user representative. A multidisciplinary Advisory Group informed the development of the study and agreed the final report. A full listing of the membership of the research team and Advisory Group is shown in Appendix 1. The final report was sent to an international panel of peer reviewers and their changes and comments were subsequently considered and incorporated.

2.1 Issues with research in this field

Determining the costs of health outcomes related to infant feeding relies on the ability to estimate the scale of differences in occurrence of those outcomes depending on feeding method. Randomised controlled trials are very rare in this field. It is seldom either ethical or feasible to randomise women to breastfeed or not; although some trials of relevant interventions exist (Kramer et al, 2001; Quigley et al, 2007b). Analysis in this field therefore relies mainly on observational data. An important aspect of this analysis is the ability to control for confounding variables, such as socio-economic background, or other systematic differences between women who breastfeed and those who do not.

A second issue is that there is no clear dividing line between 'breastfeeding' and 'not breastfeeding'. Women in the UK often use mixed feeding methods, either out of choice or as a result of constraints such as experiencing feeding problems or having to be away from their baby. The great majority of babies who start to breastfeed in the UK are fed on a mix of breastfeeding and other food and fluids, including infant formula, follow-on formula, and solids (Bolling et al, 2007).

As a result of these issues, two errors are possible. First, estimates of difference between health outcomes for women and babies who breastfeed and who do not breastfeed might be overestimated; for example, because of insufficient control for confounding factors (Horta 2007; Kramer 2009).

Were this to happen, the costs of possible diseases and conditions resulting from low breastfeeding rates would be calculated as higher than they should be. Second, the estimates of difference could be underestimated, and the costs would be calculated as lower than they should be; for example, because of the measurement error associated with treating breastfeeding as a dichotomous variable (Kramer 2009). Both of these would constitute serious methodological errors.

In this study we have adopted a methodological approach that is both systematic and transparent, taking care not to overestimate or underestimate the burden of disease or the costs resulting from artificial feeding. To avoid the risk of overestimation of costs, we consistently erred on the side of conservative assumptions when making methodological decisions.



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3 METHODS

3.1 Introduction

A range of methods was used as follows:

Systematic identification of evidence from the UK and similar high-income industrialised countries about economic consequences of diseases preventable by breastfeeding:

- A systematic search and identification of existing systematic reviews and UK studies of disease outcomes related to breastfeeding (at all, or exclusively)
- Systematic identification of strongest sources of evidence most relevant to the UK and similar countries
- A review of studies related to economic impact (cost of illness) of not breastfeeding (at all, or exclusively)

Calculating measures of effect and other summary statistics:

- Statistical analysis of the findings of relevant studies and reviews to produce summary statistics for the cost of illness models

Developing cost of illness models and narrative analyses:

- Development of cost of illness models, including identification of data to inform the prevalence and costs of disease
- Narrative analysis of the economic issues related to outcomes with extensive impact on health and on other sectors that could not be included in an economic model

Setting the findings in context:

- Illustrative example of the resources needed to implement a multifaceted, evidence-based change programme in one locality
- Examination of UK contextual evidence and policy, drawing on recent policy documents and systematic reviews

This section summarises the methods used for each stage of the study. Full descriptions of methods used are included in Appendices 2–16.

3.2 Searches to identify relevant evidence

Identifying the evidence to inform the cost of illness models was an essential foundation to this study. We needed to identify systematic reviews and studies that could provide good quality evidence related to a very wide range of disease outcomes relevant to a UK setting. Challenges in this process included:

- the extensive volume of literature in the field of infant feeding
- some studies and reviews examined only one outcome, while others examined a range of outcomes
- some reviews combined studies from developed and developing country settings
- some studies and reviews had rigorous methods for measuring exposure (initiation, duration and exclusivity of feeding methods), while many did not
- randomised controlled trials are seldom possible in this field, and existing studies and reviews do not always use robust analytical methods
- variation in the extent and nature of controls for confounding variables, and some studies do not control for these at all.

Only after assessing the strength of evidence was it possible to decide if any specific disease outcome could be included or excluded, and for some outcomes the evidence from different studies and reviews was conflicting.

The searches therefore had to be broad and inclusive, and the process of identifying included studies and reviews was conducted in a stepped process. A hierarchy of evidence was developed to assist in the final identification of relevant evidence.

We conducted three separate reviews to identify relevant information, each with its own purpose,

and inclusion and exclusion criteria. See Appendix 3 for full details of search strategies and databases searched, and Appendix 4 for screening criteria for titles and abstracts for each of the three reviews: A, B and C.

Review A: a systematic search and identification of existing systematic reviews of infant feeding and health and cognitive outcomes in developed/transitional countries.

The following inclusion criteria were used at the stage of screening the search results:

- Some or all participants breastfeeding/feeding with breastmilk
- Measured health and/or cognitive outcomes in relation to infant feeding

Exclusion criteria were:

- Reviews including only studies conducted in developing countries
- Not a systematic review

Review B: a systematic search and identification of UK studies examining health outcomes related to infant feeding.

The following inclusion criteria were used at the stage of screening the search results:

- Controlled studies conducted in the UK
- Some or all participants breastfeeding/feeding with breastmilk
- Measured health and/or cognitive outcomes in relation to infant feeding

Review C: a review of *economic impact* (cost of illness) related to infant feeding from developed/transitional countries.

The following inclusion criteria were used at the stage of screening the search results:

- Cost analyses or cost of illness studies
- Conducted in the UK or comparable industrialised countries

- Measured costs to health services of treating conditions that could have been prevented by breastfeeding
- Measured costs to other public services of meeting needs that could have been prevented by breastfeeding

3.2.1 Search results

Review A

The search results were delivered in two parts: English and languages other than English.

English search results

One researcher (FM) screened the titles and abstracts (n=9,671) using a pre-screening form based on the inclusion criteria for Review A (Appendix 4). A second researcher (AM) screened a 10% sample (n=967) as a quality check. Full papers were ordered for all citations where exclusion was not possible on the basis of citation and abstract (total of 297). 214 papers were received as pdf files from journals to which the university library subscribes. Of the remaining 83, papers were ordered only when they related to what became priority outcomes (a total of four of these papers were ordered).

Non-English search results

1,419 non-English citations were identified, 638 with an English abstract. One reviewer (FM) assessed these on title and abstract, and the remainder on title only, using the same pre-screening form. A second reviewer (AM) screened a 10% sample (n=142) as a quality check. Two further papers were ordered (seven others identified had already been ordered in translation during the English search process).

Review B

One reviewer (FM) screened the titles and abstracts (n=3,527) using a form based on the inclusion criteria for Review B (Appendix 4). A second reviewer (AM) screened a 10% sample (n=353) as a quality check. Full papers were ordered for all citations where exclusion was not possible on the basis of citation and abstract (total of 253).

Review C

The search for economic evaluations of infant feeding delivered 2,415 citations in an Endnote database. One experienced reviewer who is

not an economist (FM) and one economist (SP) independently piloted the screening process on the first 242 citations (10% of 2,415), using the pre-screen form shown in Appendix 4. There was full agreement between the two reviewers on the included and excluded papers. The remaining titles and abstracts (2,215/2,415) were therefore screened by one reviewer (FM). Copies of 37 papers were requested as a result of this process. Eleven papers were reviewed and data extracted. The results of this review, including descriptions and appraisals of the included studies, conclusions and data extraction forms, are shown in full in Appendix 5.

3.2.2 Identifying relevant systematic reviews and UK studies and identifying priority outcomes for further appraisal

The goal of this stage was to use these systematic reviews and UK studies to identify a shortlist of priority outcomes that had sufficient good quality, relevant evidence to inform the economic analyses.

We planned to identify short, medium and long-term disease outcomes for the child including babies in neonatal units, maternal outcomes, and developmental outcomes for the child.

Identifying the priority outcomes took place in several stages over which papers were gradually excluded, as follows. The 552 papers identified in the screening process (299 from Review A and 253 from Review B) were scanned to identify the outcomes examined, and divided into individual databases for each outcome identified. Papers where multiple outcomes were examined, and where those outcomes were identified as priorities, were added to more than one database. Where systematic reviews included studies from both developed and developing countries, they were examined to identify any relevant UK studies. The numbers of possible papers identified in the screening process and allocated to different categories are shown in Table 1.

Table 1: Numbers of possible papers (n=552) identified in the screening process and allocated to different categories

Category to which papers allocated	Number of papers allocated	Comment
Excluded	199	Not relevant – for example, not a systematic review or UK study, not related to the topic
45 outcomes where evidence did not meet our criteria	173	Shown in Appendix 6
Papers to be further examined (categorised below)	180	These papers were included on a long list for detailed examination and discussion and finally allocated to one of the categories below
Total papers from screening	552	
• Studies with multiple outcomes	18	One or more outcome from these studies appears in one or more of: final shortlist, final long list, 45 outcomes where evidence did not meet our criteria
• Final shortlist of eight outcomes for economic analysis	100	These were further scrutinised – details in section 4.1.1
• Final long list of further eight outcomes	62	Did not meet criteria for economic analysis. Details in section 4.1.2
Total papers to be further examined	180	

Outcomes where evidence was clearly inadequate for our purposes (for example, no systematic review or UK study existed) were excluded at this stage (n=199 papers). Outcomes where the evidence clearly did not meet our criteria were included on a list for future research (45 outcomes, 173 papers, Appendix 6). Outcomes where systematic reviews or UK studies that were assessed at this preliminary stage as having the potential to be adequate were included on a list of possible outcomes for inclusion (n=180).

Using an iterative process to examine the strength and relevance of evidence related to each outcome, the long list was then assessed by the research team and the Advisory Group using the following criteria:

- one or more reviews or studies had been identified that *either* had the potential to predict the effect size with confidence, or the evidence was not conclusive but the effect size was likely to be considerable
- it was scientifically plausible that the outcome could be related to infant feeding
- the outcome was assessed as important in a UK setting
- it was possible to conduct an economic analysis (that is, data existed in a useable form).

This process included the identification of the studies with the best quality of data for our purposes. For this, we had to develop a process for agreeing the best source of data to inform our economic analyses. This involved the assessment of the quality of evidence, and of the biological plausibility of the condition being affected by infant feeding.

3.2.3 Quality assessment and hierarchy of evidence

Randomised controlled studies in this field are very rare. We therefore anticipated that conducting analyses of available data would be complicated by: methodological problems in the original studies, the limited occurrence of exclusive breastfeeding, a wide range of different measures used for feeding history and for outcomes, and different findings related to diverse settings and population group. These factors would be likely to contribute to conflicting findings between reviews and between UK studies and review. We were also aware that the evidence available was likely to differ in quantity, quality and

relevance between outcome. The strategy we adopted to guide our analysis was to construct a stepped approach to identifying the best quality and most appropriate evidence, using a hierarchy of evidence appropriate for this study and which could be tailored to each outcome.

For each priority outcome, we planned to identify a primary source or sources of evidence; if possible, we planned to conduct meta-analyses to combine data from different studies. We also planned to identify alternative or corroborative evidence from other sources that could confirm the size of effect identified in the primary source. The primary source of evidence might be either a UK study or a systematic review, depending on the quality of available evidence for each outcome. The process for identifying appropriate evidence is outlined in Table 2. In addition to this hierarchy, a prerequisite for any study used was that it reported data by infant feeding method, and that it reported adequate measures of exposure (initiation, duration, exclusivity) to breastfeeding and use of breastmilk substitutes.

As the assessment of the characteristics of appropriate studies and reviews varied between outcomes, individual discussions involving the whole research team took place to agree each primary data source. For example, the assessment of a 'large enough' study required examination of the sample size to assess that individual outcome, and that would vary according to whether the outcome was common (for example, gastrointestinal disease) or relatively rare (for example, necrotising enterocolitis). Assessment of 'adequately controlled' required examination of related factors (for example; for obesity, was maternal BMI controlled?). The outcome of these discussions, and reasons for inclusion/exclusion of each study or review, are shown in the Results sections for each outcome.

Table 2: Hierarchy of evidence used for each outcome to identify the reviews and studies to inform the economic models.

Level of evidence	Primary source of evidence	Corroborative evidence
Level 1	One or more UK studies: the research team had to agree that it was contemporary, large enough, good quality, adequately controlled – these assessments had to be related to the outcome of interest and varied from outcome to outcome	Systematic reviews, UK studies not meeting Level 1 criteria Studies from other countries identified from systematic reviews
Level 2	Good quality meta-analysis or systematic review using studies from developed countries	Other systematic reviews UK studies not meeting Level 1 criteria Studies from other countries identified from systematic reviews
Level 3	One or more UK studies not meeting Level 1 criteria	Systematic reviews Studies from other countries identified from systematic reviews
Level 4	Systematic review not meeting Level 2 criteria	Other systematic reviews Studies from other countries identified from systematic reviews

3.2.4 Plausibility

A final important factor in our decision-making on the final shortlist of priority outcomes was biological plausibility – how likely is it that the outcome will be affected by infant feeding? Outcomes included on the final shortlist were those where plausible biological mechanisms exist, even if these are not yet fully understood. Mechanisms related to each of our shortlisted outcomes are summarised in Appendix 7.

3.2.5 Identification of priority outcomes: the shortlist

These are discussed in detail in Results: Section 4. They are reported briefly here as the next stages of the Methods required work on these specific outcomes.

Five outcomes were identified for quantitative economic modelling:

- In the infant
 - Gastrointestinal disease, lower respiratory disease, and acute otitis media
- In infants in neonatal units
 - Necrotising enterocolitis (NEC)
- In mothers
 - Breast cancer

Three outcomes were identified for narrative economic analysis, all related to the infant/child:

- Cognitive outcomes
- Sudden Infant Death Syndrome (SIDS)
- Early years obesity

3.2.6 Data extraction and quality appraisal

Systematic reviews and UK studies relating to the agreed shortlist were identified. Data were extracted by one reviewer (FM) and checked by another (MQ), and any difficulties discussed with MJR and on many occasions with the whole research team. Problems encountered included:

- the poor quality of exposure measurement (initiation, duration, exclusivity) of infant feeding
- the lack of consistency in the timing of exposure measures (examples included any breastfeeding to 6–8 weeks, still breastfeeding at time of occurrence of outcome, received any breastmilk)
- the limited occurrence of exclusive breastfeeding in developed country settings, resulting in most comparisons being confounded by mixed feeding
- very few randomised controlled trials exist due to ethical and practical problems of randomising feeding methods
- the close association of feeding with socio-cultural or other relevant factors, which may or may not have been controlled for in studies or reviews
- inadequate sample sizes.

3.3 Statistical issues

3.3.1 Calculating effect measures, exposure, adjustment for confounders, risk ratios versus odds ratios

We used the findings of the systematic reviews and UK studies identified for the shortlisted outcomes as follows:

- For each of the primary sources of data identified for each of the shortlisted outcomes, we obtained risk ratios or odds ratios as appropriate (Appendix 2, section 1.6)
- For each of the shortlisted outcomes, exposure to infant feeding methods (that is, initiation, duration and exclusivity of breastfeeding) was grouped as appropriate (Appendix 2, section 1.6.2)
- For each of the shortlisted outcomes, it was appropriate to use risk ratios or odds ratios which were adjusted for confounders, since

none of the included UK studies or meta-analyses were randomised controlled trials, and infant feeding is known to vary according to many socio-cultural factors. For each study, we assessed whether adjustment for confounders was deemed as adequate. For almost all outcomes, it was deemed as adequate and the factors which have been adjusted for are clearly described in the Results chapter and described in detail in data extraction tables in Appendix 11

- The original adjusted odds ratios were used in the economic models; details of the methodological considerations are shown in Appendix 2, section 1.6.

3.3.2 Population attributable fractions

We originally planned to use the population attributable fraction (PAF) to estimate the proportion of cases that were attributable to *not* breastfeeding. However, this proved to be difficult because the standard formulae for PAF (Bruzzi et al, 1985) are for exposures that result in an increased risk of disease (for example, smoking) rather than a protective effect. Methodological details are in Appendix 8.

3.4 Economic modelling

The aim of the economic modelling was to estimate the savings in the NHS treatment costs that could be achieved if breastfeeding rates increased and incremental quality adjusted life years (QALYs) that might be accrued in the case of breast cancer. QALYs were not estimated in relation to other outcomes modelled as they were acute diseases with a short time horizon. Objectives were to:

- a) estimate current costs to the NHS of treating diseases shown to be associated with breastfeeding given current breastfeeding rates
- b) predict the impact of increased breastfeeding on selected diseases given varying rates/definitions of breastfeeding
- c) estimate potential cost-savings per year, if any, that could be achieved by moving from the current breastfeeding rates to a particular breastfeeding rate/definition; and

- d) estimate QALYs gained and incremental benefit (combined value of QALYs with treatment costs) for reduction in breast cancer cases in a cohort of parous women

For each of the disease outcomes to be modelled, one or more odds ratios were selected to model the benefit of breastfeeding. Variation in key elements of the studies that generated odds ratios, such as variation in the definition of breastfeeding (both in terms of exclusivity and duration) and the time period in which such benefits accrued, meant that each outcome had to be modelled separately. For acute conditions (gastroenteritis, respiratory illness and acute otitis media), the first year of life was considered as the time horizon for costing whereas for maternal breast cancer it was lifetime of a cohort of parous women. For necrotising enterocolitis (NEC), it was the length of stay in neonatal units.

The perspective of the economic analysis was that of the NHS in the UK. Costs associated with *not* breastfeeding that fall on individuals or households and/or any other sectors were excluded, as were any costs of interventions to promote breastfeeding. Data on treatment costs and potential cost-savings are presented in 2009–10 prices. Where the costing time horizon is longer than a year (for example, maternal breast cancer), a rate of 3.5% was used to discount the future stream of treatment costs in baseline estimates (National Institute for Health and Clinical Excellence, 2006a).

A separate evidence review was carried out to establish the following information to inform modelling (model parameters): current breastfeeding rates; incidence of outcomes; incidence of primary and secondary care episodes specific to the selected conditions; unit costs of treatment of the condition or unit-costs of care episodes. This review relied on the most recent publications (for example, National Institute for Health and Clinical Excellence guidance, National Institute of Health Research Health Technology Assessment reports, and peer-reviewed journal articles) and hand-searching of the bibliographies of those papers. All model parameters are specific to the UK. A commentary on evidence appraisal and synthesis is included for each model and provided as Appendix 9.

3.4.1 The 7-step framework

A framework was developed to inform the modelling of all the outcomes identified, building on common methods adopted by previous studies (Weimer, 2001; Drane, 1997; Bartick and Reinhold, 2010). The common steps that were followed across all outcomes are summarised here and in Figure 1, and full details are included in Appendix 2, section 2.1.

Developing breastfeeding policy scenarios

The aim of the modelling exercise was to estimate the extent to which NHS treatment costs would be reduced if breastfeeding rates were increased. Therefore, various breastfeeding policy scenarios relative to a 'base case' were needed from which to simulate any cost-savings associated with increased breastfeeding. The variations in the definition of breastfeeding (both in terms of exclusivity and duration), the source of data on breastfeeding rates, and the time period in which benefits accrued due to breastfeeding meant that a 'universal' policy scenario was not applicable across the five outcomes considered. Therefore, outcome-specific policy scenarios were developed. Both the description and the rationale for these are described in the outcome-specific methods sections (below, section 3.4.2).

Determine the reference population

The reference population selected was either children born in the year 2009 (for child outcomes), sourced from data provided by the Office for National Statistics (ONS), or a cohort of primiparous women – first time mothers – (for maternal outcome), sourced from Euro Peristat (EURO-PERISTAT project in collaboration with SCPE EUROCAT & EURONEOSTAT, 2008).

Divide the reference population between breastfeeding groups

The reference population was divided into two groups – breastfed children or breastfeeding women and non-breastfed children or not-breastfeeding women – using breastfeeding rates derived from the Infant Feeding Survey (Information Centre for Health and Social Care, 2011), (Bolling et al, 2007), or from Liu et al (Liu et al, 2009) for breast cancer. This was used to estimate the expected number of children/women who would be breastfed/breastfeeding under each policy scenario.

Estimate expected number of disease/care episodes in each feeding group

The expected number of children or women experiencing the outcome of interest was estimated in each feeding group for each policy scenario. The differential incidence was obtained using the formula provided by Bartick and Reinhold (Bartick and Reinhold, 2010): $x = s/(br + 1 - b)$, where x = disease incidence in non-breastfeeding group, s = overall incidence of the disease in question, b = current breastfeeding rate; r = odds ratio in favour of breastfeeding, and xr = incidence of the condition in breastfeeding group. This formula is applicable when the odds ratio approximates the risk ratio.

Estimate total costs of treatment per year in each breastfeeding group under each policy scenario

The estimated number of children or women with the outcome of interest fed into the calculation of costs by estimating incidence of care episodes and multiplying by unit cost of a care episode (hospitalisation or GP visit). The costs in each feeding group were summed for total costs of the disease under each policy scenario. For maternal breast cancer, a cohort of 100,000 women were followed up over their lifetime, using a simple 3-state Markov process (cancer, no-cancer, death), to estimate the treatment costs.

Estimate total potential cost-savings per annum under different policy scenarios

Total treatment costs per year under each policy scenario were compared with the base case to ascertain the extent to which increasing breastfeeding rates would reduce health service costs. In the case of breast cancer, an additional metric – the incremental benefit that combines the value of QALYs with treatment costs – was estimated. The findings present the potential savings to the NHS that might result from increased rates of breastfeeding. No attempt has been made to estimate the net benefit to the NHS, which would require subtracting the costs of the interventions used to promote and support breastfeeding. These are discussed in Section 5.2 to help to contextualise the potential savings.

Reflecting some degree of uncertainty in predicted cost-savings

Parameters used in the modelling exercise (for example, odds ratio and treatment costs) were derived from studies and reviews with varying characteristics (for example, design, sample size, definition of breastfeeding). Inevitably, there is some degree of uncertainty about the point estimates reported in individual studies and, in some instances, the degree to which these are applicable to a UK NHS setting. Deterministic sensitivity analyses thus assessed the impact on the predicted cost-savings of the uncertainties around odds ratio and unit costs of treating the health-outcomes. These parameters were selected to capture the changes in both outcomes (expected number of cases) and costs to treat those cases. Methods used are shown in detail in Appendix 2, section 2.1.

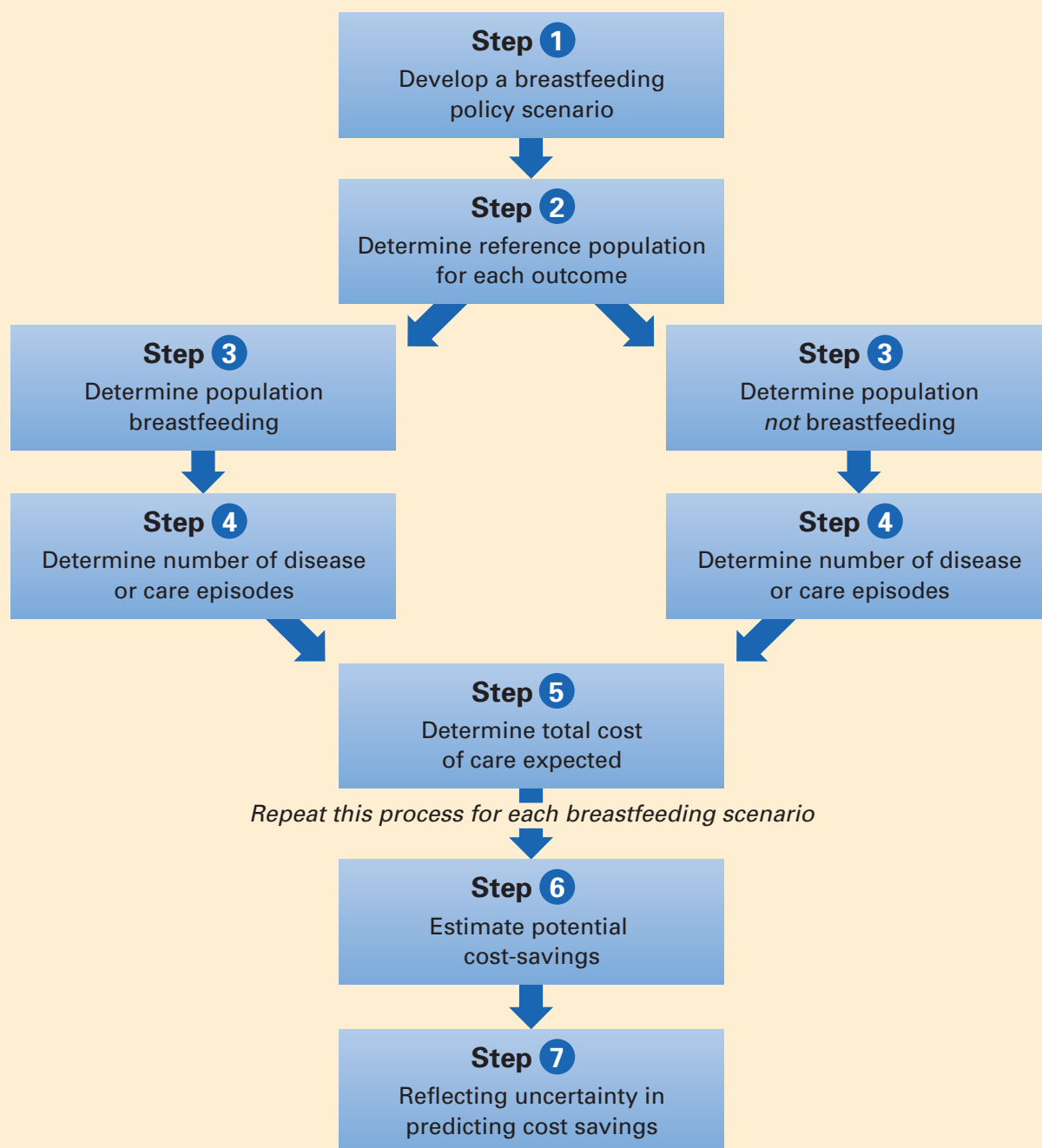
This 7-step framework is similar to the methods adopted by similar studies conducted in non-UK settings (Weimer, 2001; Drane, 1997; Bartick and Reinhold, 2010). However, it builds on the previous methods by:

- a) including more realistic policy scenarios for four of the five priority outcomes (excluding necrotising enterocolitis), based on our critical analysis of existing UK-specific breastfeeding data, rather than just relying on a hypothetical target
- b) limiting, to the extent possible, the use of model parameters from the same setting; and
- c) reflecting some degree of uncertainty in final estimates of cost-savings through a range of deterministic sensitivity analyses.

In addition, the selection of risk ratios on which the current models work is the outcome of a series of structured reviews undertaken specifically for this project. Together, they make the current study more robust and relevant to the UK context.

Figure 1

Schematic diagram of 7-step process of economic modelling



3.4.2 Outcome-specific methods

Policy scenarios

As Figure 1 shows, methods were developed specifically for each outcome modelled. Full details are given in Appendix 2, section 2.2, and see Appendix 10 for policy scenarios modelled and key parameters used for five disease outcomes.

A key part of the modelling was the development of a range of realistic options for increased rates of breastfeeding (section 3.4.2.1). These policy scenarios varied from outcome to outcome. In developing these UK-wide scenarios, we recognised that breastfeeding rates are very diverse across localities. Initiation rates in PCTs in England vary from 42.5% to 92.5%, for example, and rates of any breastfeeding at 6-8 weeks range from 19.4% to 83.2% (ChiMat Data Atlas, 3 August 2012 <http://bit.ly/OETfjL>).

The work needed to increase breastfeeding rates will therefore vary from locality to locality.

To ensure that the national scenarios were realistic in the UK context, we used existing UK rates as the basis for our calculations. We assumed that with appropriate care and support, and noting that 90% of women in the UK who stop breastfeeding before six weeks do so before they wish to (Bolling et al, 2007), women throughout the UK could continue to breastfeed for considerably longer than at present. So, for example, scenario A1, shown below, was to increase the rate of breastfeeding at four months to the current rate at six weeks (21%). The rates we have chosen are lower than those seen in other European countries (Huus et al, 2008).

Table 3: Policy scenarios modelled for predicting the impact of increased breastfeeding rates on gastrointestinal infection, lower respiratory tract infection, and acute otitis media in infants against varying rates/definitions of breastfeeding.

Definition of breastfeeding and rate used (2005) in base case	Alternative policy scenarios modelled		
Scenario A0 (current rates): Exclusive breastfeeding (EBF) rate at 4 months (7%)	A1: increase rate of exclusive breastfeeding at 4 months to rate at 6 weeks (21%)	A2: increase rate of exclusive breastfeeding at 4 months to rate at 1 week (45%)	A3: increase rate of exclusive breastfeeding at 4 months to rate at birth (65%)
Scenario B0: Exclusive breastfeeding (EBF) rate at 6 months (0.5%)	B1: increase rate of exclusive breastfeeding at 6 month to rate at 4 months (7%)		
Scenario C0: 'any breastfeeding' rate at 6 months (25%)	C1: increase rate of 'any breastfeeding' at 6 months to rate at 6 weeks (48%)		

Table 4: Policy scenarios modelled for predicting the impact on necrotising enterocolitis (NEC) of increasing rate of breastmilk feeding for varying rates of 'any breastmilk feeding' at discharge within neonatal units

Definition of breastmilk feeding and rate used (2006) in base case	Alternative policy scenarios modelled		
Scenario D0: (current rates): Any breastmilk feeding rate at discharge from neonatal units (35%)	Scenario D1: increase rate of any breastmilk feeding at discharge from neonatal units to 50%	Scenario D2: increase rate of any breastmilk feeding at discharge from neonatal units to 75%	Scenario D3: increase rate of any breastmilk feeding at discharge from neonatal units to 100%

Table 5: Policy scenarios modelled against current practice for predicting the impact of increased breastfeeding on maternal breast cancer.

Definition of 'lifetime' breastfeeding and rate used (1996-2001) in base case	Alternative policy scenarios modelled		
Scenario E0 (current rates): 32% parous women never breastfeeding 36% breastfeeding for ≤6 months 16% breastfeeding for 7-18 months 16% breastfeeding for 18+ months	Scenario E1: Increase rate of breastfeeding for ≤6 months to 52% 16% never; 52% ≤6 months; 16% 7-18 months 16% 18+ months	Scenario E2: Increase rate of breastfeeding for ≤ 18 months to 32% 16% never 36% ≤6 months 32% 7-18 months 16% 18+ months	Scenario E3: Increase rate of breastfeeding for 18+ months to 32% 16% never 36% ≤6 months 16% 7-18 months 32% 18+ months

Odds ratios

Odds ratios for the difference in disease prevalence related to different infant feeding patterns used for each outcome are shown in Section 4.3 for each model, and the basis of their calculation is shown in detail in Appendix 2, Section 2.

3.4.3 Methods of narrative economic analyses

We developed narrative commentaries to consider the financial impacts of the three conditions where quantitative modelling was not possible: cognitive outcomes, Sudden Infant Death Syndrome (SIDS), and early years obesity. These analyses are necessarily less detailed than the quantitative models, as data on both prevalence and costs were more limited. For each outcome examined, we investigated the conditions and the potential benefits that might accrue as a result of changes in breastfeeding rates. Given the nature of the conditions, which are long-lasting and with a wide-reaching impact, for these outcomes we examined some of the savings that could result inside and the NHS and in wider society. We used 2009 UK data on prevalence and rates where possible. In some cases, only data from England and Wales was available. In these circumstances, we extrapolated from these data to provide UK costings. We drew on a range of sources for costing the impact of these conditions, including US sources where UK studies were not available. The specific sources used for each outcome are shown in detail for each narrative in Section 4.5. Costs have not been discounted.

3.4.4 Setting the findings in context

To contextualise the findings, we examined UK evidence and policy, drawing on recent UK policy documents and systematic reviews. In addition, we have provided an illustrative example of the resources needed to implement a multifaceted, evidence-based change programme in one locality. This stage of the project is reported in Section 5 and Appendices 14–17.

4 RESULTS

4.1 Results of review process to identify priority outcomes and examine existing data

All the outcomes examined in studies identified in our searches were assessed for adequacy of evidence to inform the development of economic models. The best available evidence related to a “shortlist” of five quantitative and three narrative outcomes. A long list of a further eight outcomes was also compiled. This consisted of conditions in which there was evidence of a relationship to not being breastfed, but which was insufficient for economic modelling or narrative review. A further 45 outcomes where evidence was much weaker are listed in Appendix 6.

4.1.1 The shortlist of priority outcomes

Table 6 shows the final decisions on eight priority outcomes following assessment against the selection criteria, together with the 25 systematic reviews and UK studies that we identified and used in five economic models and three narrative analyses. Data extraction tables for these systematic reviews and studies forming the evidence base for the shortlisted outcomes are shown in Appendix 11.

Final data used to inform the economic models (n=5) were developed from the studies identified and are shown in Section 4.3.

Table 6: Shortlist of eight outcomes for economic analysis, where evidence adequate for economic modelling (5) or narrative review (3)

Whose outcome	What outcome	Economic model or narrative review	References identified (Bold = primary source of data)
Baby/child	Gastrointestinal infection	Full economic model developed	Quigley et al 2006, 2007a Howie et al, 1990 Fisk et al, 2011 Baker et al, 1998 Kramer and Kakuma, 2002
Baby/child	Respiratory tract infection	Full economic model developed	Quigley et al 2007a Fisk et al, 2011 Howie et al, 1990 Ip et al, 2007 Bachrach et al, 2003 McNeil et al, 2010 Kramer and Kakuma, 2002
Baby/child	Otitis media	Full economic model developed	Fisk et al, 2011 Ip et al, 2007, 2009
Babies in neonatal units	Necrotising enterocolitis	Full economic model developed	Henderson et al, 2009 Ip et al, 2007 McGuire and Anthony, 2003 Quigley et al, 2007b Lucas et al, 1990
Mother	Breast cancer	Full economic model developed	Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002 Bernier et al, 2000 Lipworth et al, 2000 Ma et al, 2006 Yang and Jacobsen, 2008
Baby/child	Obesity	Narrative review of economic issues	Horta et al, 2007 Armstrong and Reilly, 2002 Li et al, 2003 Reilly et al, 2005 Wilson et al, 1998
Baby	SIDS	Narrative review of economic issues	Hauck et al, 2011
Child and babies in SCBU	Cognitive outcomes	Narrative review of economic issues	Quigley et al, 2012 Iacovou et al, 2010

4.1.2 Other outcomes identified

The 'long list' of outcomes with important evidence to consider

Outcomes included on the final **long list** were those where it was deemed plausible that the outcome is related to infant feeding, and where we identified evidence to demonstrate the relationship, but where the strength of the evidence, or the way in which outcomes or infant feeding had been measured, was inadequate to inform an economic analysis. There were several reasons for this, including

- a) the measurement of infant feeding in the available studies did not differentiate adequately between exclusive, partial and no breastfeeding,
- b) potentially confounding variables were not adequately controlled, and
- c) evidence was not in a form that allowed for economic modelling.

For example, although an increase in the prevalence of cardiovascular disease seems likely to be an expensive consequence of not breastfeeding it is difficult to extrapolate from markers of cardiovascular disease in childhood to the actual costs of cardiovascular disease in adulthood. This outcome could therefore not be included on the final shortlist for economic analysis.

Asthma is another example: asthma is a disease where genetics interacts with environmental factors and dietary intake, but the majority of studies in the field have not addressed this interaction, and many have not adequately considered the importance of exclusive (as opposed to any) breastfeeding and avoidance of any early exposure to potential allergenic triggers. Current evidence is conflicting and so this outcome was also not included on the shortlist. We have included this long list to demonstrate the potential extent of the economic consequences of not breastfeeding in the UK, which is likely to be much greater than the quantitative models we have been able to develop, and to act as a research agenda for future studies of the costs of disease and developmental outcomes.

Table 7 shows the long list of eight outcomes where there was important evidence to consider, but where it did not meet our strict criteria for economic analysis. These are outcomes where further research would help to clarify the effect size associated with mode of infant feeding.

Outcomes for which good quality evidence was not identified

Absence of a condition from either the short or long list of priority outcomes does not necessarily mean that there is no association between that condition and infant feeding; it simply indicates current lack of good quality evidence. The 45 outcomes identified in 173 reviews and studies (Appendix 6) therefore represent an important research agenda.

Table 7: Final long list of eight outcomes: maternal (2) and child (6) outcomes where there was evidence of the relationship with infant feeding, but where the evidence was not in a form that could be used for this study. Reasons for this decision are shown.

Whose outcome	What outcome	Reason for exclusion from short list	Relevant references: systematic reviews (SRs) and UK studies	Comment
Mother	Ovarian cancer	Inadequate evidence for modelling (ORs were estimated in half the six included studies)	Ip et al, 2007/2009 (SR)	Important, can be costed
Mother	Type 2 diabetes	Evidence from only one study (of US nurses, Stuebe 2005)	Ip et al, 2007/2009 (SR)	Important, can be costed, expensive chronic disease
Child	Asthma	Exposure and outcome measures inadequate. Genetic, environmental and dietary factors interact.	Gdalevich et al, 2001 (SR); and Davidson et al, 2010, Hide et al, 1996, Kaplan and Mascie-Taylor, 1985, Karmaus et al, 2008, Scott et al, 2010, Taylor et al, 1983, Turner et al, 2008 (UK studies)	Important, costable, expensive chronic disease
Child	Diabetes	Inadequate evidence for modelling.	Norris and Scott, 1996, Owen et al, 2006 (SRs); and Bodington et al, 1994, Eurodiab Substudy 2 Study Group 2002, Jones et al, 1998, McKinney et al, 1999, Patterson et al, 1994, Robertson and Harrild, 2010, Viner et al, 2008, Wadsworth et al, 1997 (UK studies)	Important, can be costed, expensive chronic disease
Child	Leukaemia	Inadequate evidence for modelling.	Guisse et al, 2005, Kwan et al, 2004 (SRs) and Lancashire et al, 2003, Murray et al, 2002 (UK studies)	Important, can be costed
Child	Coeliac disease	Inadequate evidence for modelling.	Akobeng et al, 2006 (SR); and Challacombe et al, 1997, Kelly et al, 1989 (older UK studies)	Important, can be costed, chronic disease
Child	Cardiovascular disease	Evidence based mainly on bio-markers rather than disease - inadequate for modelling	Das, 2004, Martin, et al 2005a, Owen et al, 2003, Owen 2008 (SRs); and Owen et al, 2002, Fall et al, 1992, Holmes et al, 2010, Khan et al, 2009, Lawlor et al, 2008, Martin et al 2004a, Martin, et al 2004b, Martin et al 2005b, Martin, et al 2005c, Pearce et al, 2009 and UK studies of premature infants, Singhal et al, 2001, Lucas and Morley, 1994 (UK studies)	Important, can be costed, expensive chronic disease
Babies in neonatal units	Sepsis	Exposure measures inadequate	De Silva et al, 2004, Quigley et al, 2007b (SRs); and Furman et al, 2003 (US study)	Important, can be costed

4.2 Results of economic review

Of the 11 papers reviewed, seven were reported from the USA, two from Europe (Italy and the Netherlands) and two from Australia. The majority (7/11) were published in peer-reviewed journals as full papers; two were summary reports in peer-reviewed journals and two were reports to government departments. All papers were published between 1997 and 2010. Of nine papers that were published in peer-reviewed journals, four were published in paediatric journals.

They varied significantly in terms of methods, breastfeeding rates, types of health resource used and disease conditions, making it difficult to compare the results in a meaningful way. Despite this variability, there is a consistent indication that increasing the prevalence of breastfeeding would lead to substantial reductions in health service costs in high income countries.

Full results of this review are reported in Appendix 5.

There is a consistent indication that increasing the prevalence of breastfeeding would lead to substantial reductions in health service costs in high-income countries.

Katie and Micah

Katie gave birth to Micah nearly 4 weeks early. She knew she wanted to breastfeed, but because he was premature his sucking reflex wasn't strong and latching on was difficult. Katie recalls that

I had support at home from the midwife and health visitor, when I said my son hadn't latched on yet

staff encouraged her to keep trying to breastfeed, but were unable to give her any practical help. Micah was being given formula milk while Katie tried to breastfeed. Once she got home the community midwife and health visitor asked her to show them what she was doing, and they were able to give her some helpful advice

and establish breastfeeding. They also pointed Katie to a local breastfeeding support group in the area, where mothers could go to share experiences and get advice, which she found very useful.



4.3 Results of economic models

4.3.1 Economic analysis of gastrointestinal infection in infants

Table 8: Reviews and studies considered for use in calculating a summary statistic to inform economic modelling – gastrointestinal infection in infants

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used for modelling ✓ whether used as corroborative evidence, or reasons not used
Systematic Reviews (n=5)		
Ip et al, 2007/2009	✓	Not used – relevant evidence based on Howie et al 1990 (see below)
Kramer and Kakuma, 2002	✓	Not used, but data from the large Belarus study included in this review was used as corroborative evidence
Duijts et al, 2009	Does not report a summary statistic	Not used
Gutierrez-Castrellon et al, 2007	Does not report association between breastfeeding and gastrointestinal infection	Not used
Chak et al, 2009	Outcome is <i>H. Pylori</i> infection in later life, not gastrointestinal infection in infancy	Not used
UK studies (n=6)		
Howie et al, 1990	✓	Used as corroborative evidence - larger study and more recent data available
Quigley et al, 2006	✓	✓ used for GP cases and general morbidity data
Quigley et al, 2007a/2009 (same study)	✓	✓ used for hospitalisation data
Sethi et al, 2001/1999 (same study)	Small numbers, overlap with Quigley, 2006	Not used
Fisk et al, 2011	✓	Used as corroborative evidence – larger study with better exposure measurement available
Baker et al, 1998	✓	Use as corroborative evidence – larger study and more recent data available

Table 9 below shows the hierarchy of evidence used for gastrointestinal infection. For explanation of evidence hierarchy, see Section 3.2.3 and Appendix 2, section 1.5.1. For details of methods and details of studies see the relevant data extraction forms (Appendix 11).

Table 9: Gastrointestinal infection in infants – hierarchy of evidence used for economic modelling. For details of all studies see Appendix 11.

Primary source of evidence	Corroborative evidence
For hospitalisation data Quigley et al, 2007a	Howie et al, 1990 Fisk et al, 2011 Baker et al, 1998 Kramer and Kakuma, 2002
For GP cases and general morbidity Quigley et al, 2006	

Calculating the summary statistic to be used for economic modelling

The studies identified as primary data sources for economic modelling were Quigley et al (2006, 2007a).

Table 10 shows the adjusted odds ratios (ORs) for different categories of current infant feeding in these studies. In particular, odds ratios are provided for the binary comparisons exclusive breastfeeding compared with 'not exclusive breastfeeding', and any breastfeeding compared with 'no breastfeeding'. Note that the results show the 'effect of breastfeeding currently on gastrointestinal infection not the effect of any previous breastfeeding which had stopped prior to the point of data collection. Full data on input parameters may be found in Appendix 12.

Table 10: Gastrointestinal infection in infants – input parameters used in economic analysis

Odds ratios in favour of breastfeeding	Incidence	Unit costs (2009/10 prices)
Exclusive breastfeeding: Hospitalisation: 0.39 (0.18-0.85) GP visits: 0.28 (0.11-0.69) Any breastfeeding: Hospitalisation: 0.52 (0.30-0.87) GP visits: 0.36 (0.18-0.74)	Hospital admissions: 17.2/1000 live births Primary care consultations: 4,682/100,000 infants <1 year	Hospital admissions: Baseline: £989 per admitted child Lower quartile: £586 Upper quartile: £1,206 Primary care consultation: Baseline: £36 per GP consultation Upper end cost: £53

The figures in parentheses are 95% confidence interval.



Any breastfeeding compared with no breastfeeding

The adjusted ORs quantifying the effect of *any* breastfeeding on the current risk of gastrointestinal infection ranged between 0.36¹ and 0.52².

Exclusive breastfeeding compared with not exclusive breastfeeding

The adjusted ORs, quantifying the effect of *exclusive* breastfeeding on current risk of gastrointestinal infection, ranged between 0.28³ and 0.39⁴. The OR for exclusive breastfeeding in the past month, compared with not exclusively breastfeeding in the past month, is 0.39. The group 'not exclusively breastfeeding in the past month' will include some babies who were never breastfed and others who were exclusively breastfed but not within the past month.

1 Small study based on GP cases

2 Large study based on hospital admissions; note that this figure is not published

3 Small study based on GP cases

4 Large study based on hospital admissions; note that this figure is based on a re-analysis and is not published

Economic analysis of gastrointestinal infection in infants

Table 11 provides point estimates of cost-savings that could be achieved per annum from reduced incidence of gastrointestinal infections and the associated treatment costs by increasing breastfeeding rates. The data show that approximately £1.2 million per annum could be saved in hospitalisation costs by increasing the exclusive breastfeeding rate at 4 months (7%) to 21% (current exclusive breastfeeding rate at 6 weeks). As this rate increases further to 45% (the current rate at 1 week), estimated cost savings in hospitals increase to £3.2 million per annum. Higher cost-savings (£5m per annum) from hospitalisations could be achieved by moving from 7% exclusive breastfeeding at 4 months to 65% (the breastfeeding rate observed at birth). Cost savings from reducing gastroenteritis-related primary care (GP) consultations in newborn children range from £141,000 to £0.6 million per year. This table also shows that savings per infant per year from both hospital and primary care costs range from approximately £1.70 if exclusive breastfeeding increased to 21% at four months, to approximately £7 if exclusive breastfeeding increased to 65% at four months.

Table 11: Estimation of potential savings per year in treating gastrointestinal infections in infants less than one year old, due to varying increases in different definitions of breastfeeding rates (refers to 788,486 infants' first year of life): showing potential savings, £ sterling. For details of all model parameters and scenarios, see Section 3.4.2.1 and Appendices 2 and 10.

Policy options	Hospitalisation costs		Primary care costs		Total costs	
	Estimate of cost-savings per year	Potential saving per infant per year	Estimate of cost-savings per year	Potential saving per infant per year	Estimate of cost-savings per year	Potential saving per infant per year
Policy A1: increase exclusive breastfeeding from 7% to 21% at 4 months	£1,197,081	£1.52	£141,083	£0.18	£1,338,164	£1.70
Policy A2: increase exclusive breastfeeding from 7% to 45% at 4 months	£3,249,221	£4.12	£382,939	£0.49	£3,632,160	£4.61
Policy A3: increase exclusive breastfeeding from 7% to 65% at 4 months	£4,959,337	£6.29	£584,486	£0.74	£5,543,824	£7.03
Policy B1: increase exclusive breastfeeding from 0.5% to 7% at 6 months	£555,788	£0.70	£65,503	£0.08	£621,291	£0.79
Policy C1: increase 'any breastfeeding' from 25% to 48% at 6 months	£1,683,450	£2.14	£232,907	£0.30	£1,916,358	£2.43

Figure 2 illustrates how annual treatment costs of gastrointestinal infection fall as the specified breastfeeding rate rises. The largest gain occurs when current exclusive breastfeeding rates at four months are increased to the most optimistic level; that is from 7% (current rates) to 65%.

These figures, using our mid-range policy scenario, indicate that 3,285 gastrointestinal infection-related hospital admissions and 10,637 GP consultations would be averted.

Sensitivity analyses based on the range of odds ratios identified (Appendix 13) suggest that cost savings from hospitalisation and GP consultations for gastrointestinal infection might range from as low as £340,000 to as high as £1.78 million per annum if exclusive breastfeeding rates were to increase to 21% at four months, and from as low as £1.34 million to as high as £7.4 million per annum if they were to increase to 65% at four months.

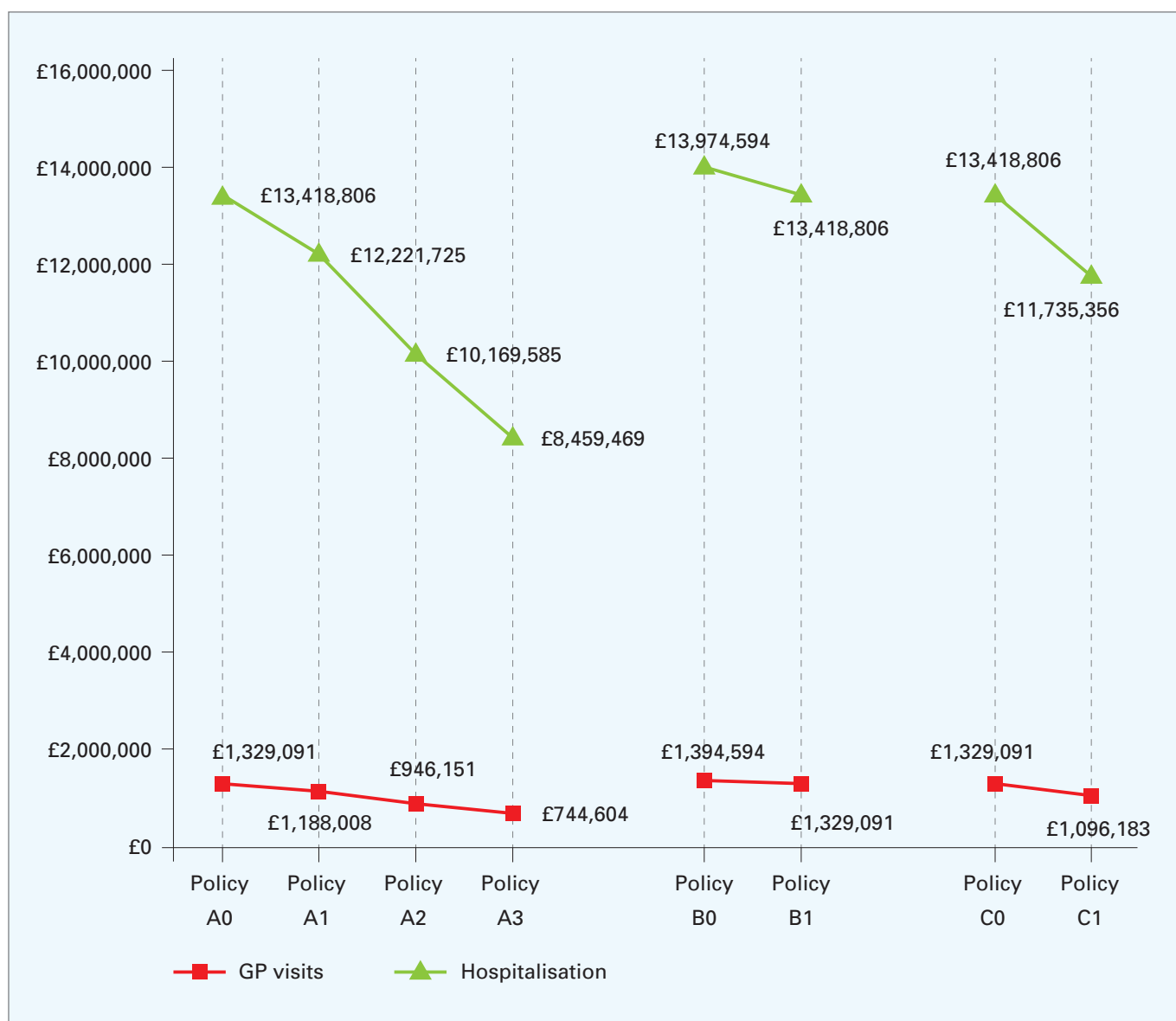


Figure 2 Fall in annual cost of treating GI following rises in (exclusive or any) breastfeeding (refers to 788,486 infants' first year of life, £ sterling)

Gastrointestinal infection in infants: summary

Five systematic reviews and six UK studies were considered for use in our economic analysis. Data from one review and three UK studies were used as corroborative evidence. The sources considered to best meet the specifications required for this outcome were Quigley et al, 2007a (for hospitalisation episodes), and Quigley et al, 2006 (for primary care consultations).

Economic analysis showed that approximately £1.34 million per annum could be saved in treatment costs in hospital and community by increasing the current exclusive breastfeeding rate at four months (7%) to 21%. Cost savings would increase to £3.6 million per annum if the rate at four months were to increase to 45%, and £5.6 million per annum could be saved annually if the rate were to rise to 65% at four months. Using our mid-range policy scenario, 3,285 gastrointestinal infection-related hospital admissions and 10,637 GP consultations would be averted.

4.3.2 Economic analysis of lower respiratory tract infection in infants

Table 12: Reviews and studies considered for use in calculating a summary statistic to inform economic modelling – lower respiratory tract infection in infants

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used for modelling ✓ whether used as corroborative evidence, or reasons not used
Systematic Reviews (n=5)		
Ip et al, 2007/2009	✓	Used as corroborative evidence. More appropriate and contemporary UK data available
Bachrach et al, 2003	✓	Used as corroborative evidence. More appropriate and contemporary UK data available
McNeil et al, 2010	✓	Used as corroborative evidence. More appropriate and contemporary UK data available
Kramer and Kakuma, 2002	✓	Used as corroborative evidence. More appropriate and contemporary UK data available
Gutierrez-Castrellon et al, 2007	Does not report association between breastfeeding and respiratory tract infection	Not used
Chien and Howie, 2001	Does not report a summary statistic	Not used
Duijts et al, 2009	Does not report a summary statistic	Not used
UK studies (n=6)		
Downham et al, 1976	Old data, exposure unclear	Not used
Watkins et al, 1979	Old data, adjustment for confounders unclear	Not used
Pullan et al, 1980	Old data, exposure unclear	Not used
Howie et al, 1990 and follow up in Wilson et al, 1998	✓	✓ Howie et al used for primary care data on exclusive breastfeeding. Wilson et al not used (long term follow up data not relevant).
Quigley et al, 2007a/2009	✓	✓ Used for hospitalisation data
Fisk et al, 2011	✓	✓ Used for primary care data on any breastfeeding

Calculating the summary statistics to be used for economic modelling

Table 13 below shows the evidence used to estimate the risk of lower respiratory tract infection in infants. For an explanation of evidence hierarchy, see Section 3.2.3 and Appendix 2, section 1.5.1. For details of methods and specific studies, see the relevant data extraction forms (Appendix 11).

Table 13: Lower respiratory tract infection – hierarchy of evidence used for economic modelling.

Primary source of evidence	Corroborative evidence
For hospitalisation data <ul style="list-style-type: none"> Quigley et al, 2007a/2009 For GP cases <ul style="list-style-type: none"> Fisk et al, 2011 Howie et al, 1990 	Ip et al, 2007 Bachrach et al, 2003 McNeil et al, 2010 Kramer and Kakuma, 2002

Quigley et al (2007a) quantified the effect of breastfeeding currently on respiratory tract infection (RTI), but did not estimate the effect of prior breastfeeding that had ceased at the point of data collection. On the other hand, Fisk et al (2011) and Howie et al (1990) took into account the effect of any previous breastfeeding on current risk of infection.

The outcomes of interest were hospitalisation or GP consultation for lower respiratory tract infection (LRTI), defined variously in the three studies as parental report of: ‘a hospital admission for chest infection or pneumonia’ (Quigley et al, 2007a,

Quigley et al, 2009); ‘head cold, accompanied by cough or wheeze’ (Howie et al, 1990); and maternal report of infant having been ‘diagnosed by a doctor with a range of respiratory infections’ (Fisk et al, 2011). These definitions did not include those with a diagnosis of ‘wheezing or asthma’.

Table 14 below shows the odds ratios and confidence intervals derived from Quigley et al (2007a/2009) for hospitalisation data, and from Fisk et al (2011) and Howie et al (1990) for GP cases; and other input parameters used for the model. Full data on input parameters is in Appendix 12.

Table 14: Lower respiratory tract infection in infants – input parameters used in economic analysis.

Odds ratios in favour of breastfeeding	Incidence	Unit costs (2009–10 prices)
Exclusive breastfeeding: Hospitalisation: 0.70 (0.49–0.98) GP visits: 0.69 (0.47–1.0)	Hospital admissions: 59.1/1000 live births Primary care consultations: 23,433/100,000 infants <1 year	Hospital admissions: Baseline: £1,078 per admitted child Lower quartile: £749 Upper quartile: £1290 Primary care consultation: Baseline: £36 per GP consultation Upper end cost: £53

The figures in parentheses are 95% confidence interval.

Economic modelling – lower respiratory tract infection in infants

Table 15 provides point estimates of potential cost-savings that could be achieved per year from reduced treatment costs by increasing breastfeeding rates from varying rates and definitions of breastfeeding. The data show that approximately £2 million per year could be saved in hospitalisation costs by increasing the exclusive breastfeeding rate at 4 months (7%) to 21% (exclusive breastfeeding rate at 6 weeks). As this rate increases further to 45% (the rate at 1 week), estimated cost savings in hospitals increase to £6 million per annum. The highest cost-savings per year from hospitalisations (£9m) could be achieved by moving from the 7% exclusive breastfeeding at 4 months to 65% (the breastfeeding rate observed at birth). Cost savings from reducing LRTI-related primary care (GP) consultations in newborn children range from £300,000 to £1.2 million per year.

Table 15 also shows that cost savings per infant per year resulting from hospitalisation and primary care costs range from approximately £1.40 (if exclusive breastfeeding increased to 7% at six months) to approximately £12.80 (if exclusive breastfeeding increased to 65% at four months).

Figure 3 summarises how annual treatment costs of lower respiratory tract infection in infants would fall if the proportion of women sustaining breastfeeding were to rise. The largest gains are associated with an increase in the prevalence of exclusive breastfeeding at 4 months to 65%.

These figures indicate that using our mid-range policy scenarios, **5,916** lower respiratory tract infection-related hospital admissions and **22,248** GP consultations would be averted.

Table 15: Estimation of potential savings per year in treating LRTI in infants less than one year old, due to increases in varying definitions of breastfeeding rates (refers to 788,486 infants' first year of life). For details of all model parameters and scenarios, see Section 3.4.2.1 and Appendices 2 and 10.

Policy options	Hospitalisation costs		Primary care costs		Total costs	
	Estimate of cost-savings per year	Potential saving per infant per year	Estimate of cost-savings per year	Potential saving per infant per year	Estimate of cost-savings per year	Potential saving per infant per year
Policy A1: increase exclusive breastfeeding from 7% to 21% at 4 months	£2,155,927	£2.73	£295,076	£0.37	£2,451,003	£3.11
Policy A2: increase exclusive breastfeeding from 7% to 45% at 4 months	£5,851,803	£7.42	£800,920	£1.02	£6,652,723	£8.44
Policy A3: increase exclusive breastfeeding from 7% to 65% at 4 months	£8,931,700	£11.33	£1,222,457	£1.55	£10,154,157	£12.88
Policy B1: increase exclusive breastfeeding from 0.5% to 7% at 6 months	£1,000,966	£1.27	£137,000	£0.17	£1,137,966	£1.44
Policy C1: increase 'any breastfeeding' from 25% to 48% at 6 months	£4,157,222	£5.27	£586,785	£0.74	£4,744,007	£6.02

Sensitivity analyses based on the range of odds ratios identified (Appendix 13) suggest that cost savings from hospitalisation and GP consultations for lower respiratory tract infection might range from as little as £441,000 to as much as £4.5 million per annum if exclusive breastfeeding rates were to rise to 21% at four months. A cost saving of between £1.7 million and £17 million per annum would be achieved if 65% of women were to breastfeed exclusively for the first four months of the infant's life.

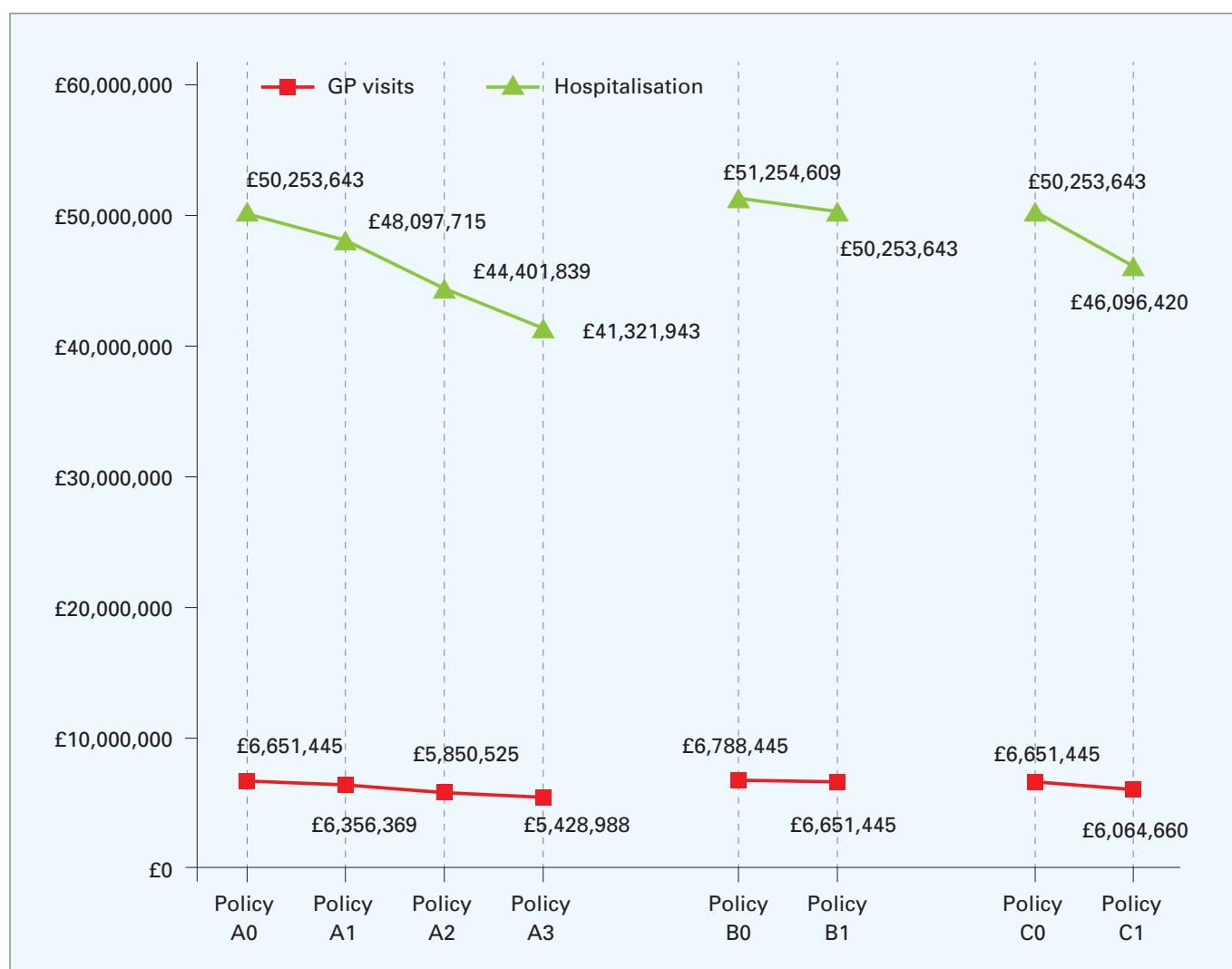
Lower respiratory tract infection in infants: summary

Seven systematic reviews and six UK studies were considered for use in our economic analysis. Data from four of these systematic reviews were used

as corroborative evidence. The sources considered to meet most closely the specifications required for modelling were Quigley et al (2007a and 2009) for hospitalisation data, and Howie et al (1990) and Fisk et al (2011) for primary care consultations.

Economic analysis showed that approximately £2.5 million per annum could be saved in treatment costs in hospital and community if the current exclusive breastfeeding rate at four months (7%) were to increase to 21%. Cost savings would increase to £6.7 million per annum if the rate at four months increased to 45%, and £10 million per annum could be saved annually by increasing the rate to 65% at four months. Using our mid-range policy scenarios, 5,916 lower respiratory tract infection-related hospital admissions and 22,248 GP consultations would be averted.

Figure 3: Fall in annual cost of treating LRTI following rises in (exclusive or any) breastfeeding (refers to 788,486 infants' first year of life).



4.3.3 Economic analysis of acute otitis media in infants

Table 16: Reviews and studies considered for use in calculating a summary statistic to inform economic modelling – acute otitis media in infants (AOM)

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used for modelling ✓ whether used as corroborative evidence, or reasons not used
Systematic Reviews (n=9)		
Ip et al, 2007/2009	✓	✓ Same comparison group (never breastfed) and outcome (AOM) as Fisk 2011 (UK study). Used for data on exclusive breastfeeding
McNeil et al, 2010	Same data as Ip, 2007/2009	Not used
Uhari et al, 1996	Included by Ip, 2007/2009	Not used
Campbell, 1996	Does not report a summary statistic	Not used
Lubianca Neto, 2006	Does not report a summary statistic	Not used
Charlton, 1994	Exposure is smoking, not breastfeeding	Not used
Cunningham, 1991	Non-systematic literature review	Not used
Wagner, 2009	Outcome is bronchiolitis, not AOM	Not used
Rovers, 2006	Outcome is distribution of risk factors for otitis media (OM), not association of AOM with infant feeding	Not used
UK studies (n=3)		
Howie, 1990	Comparison groups and outcome differ between these studies and also differ from those in Fisk, 2011	Not used
Bennett, 1998		Not used
Fisk, 2011	✓	✓ Large study, most recent data, same comparison group (never breastfed) and outcome (AOM) as Ip2007/2009. Used for data on any breastfeeding.

Table 17: Acute otitis media in infants - hierarchy of evidence used for economic modelling. Details of studies included in Appendix 11.

Primary source of evidence	Corroborative evidence
For data on any breastfeeding <ul style="list-style-type: none"> Fisk et al, 2011 	None
For data on exclusive breastfeeding <ul style="list-style-type: none"> Ip et al, 2007/09 	

Calculating the summary statistics to be used for economic modelling

Table 17 shows the hierarchy of evidence used for acute otitis media (AOM) in infants. For explanation of evidence hierarchy, see Section 3.2.3 and Appendix 2, section 1.5.1. For details of methods and details of studies, see the relevant data extraction forms in Appendix 11.

Table 18 below shows the odds ratios and confidence intervals derived from Fisk et al (2010) for any breastfeeding and from Ip et al (2007) for exclusive breastfeeding; and other input parameters used for the economic model. Note that only primary care data was used, as it is uncommon to admit infants to hospital following a clinical diagnosis of otitis media (OM), and no data exist on whether or not breastfeeding has an effect on hospitalisation for otitis media in the UK. Full data on input parameters appear in Appendix 12.

Table 18: Acute otitis media in infants – input parameters used in economic analysis

Odds ratios in favour of breastfeeding	Incidence	Unit costs (2009–10 prices)
Exclusive breastfeeding: GP visits: 0.50 (0.37-0.70)	Primary care consultations: 136/100,000 infants <1 year	Primary care consultation: Baseline: £36 per GP consultation Upper end cost: £53
Any breastfeeding: GP visits: 0.40 (0.21-0.76)		

The figures in parentheses are 95% confidence interval.

Economic modelling: acute otitis media in infants

Table 19 provides point estimates of treatment cost-savings that could be achieved each year by increasing breastfeeding rates. The data show that approximately £0.3 million per annum could be saved in GP consultation costs by increasing the exclusive breastfeeding rate at 4 months (7%) to 21% (exclusive breastfeeding rate at 6 weeks). If this were to increase further to 45% (the current rate at 1 week), cost savings in GP consultations would increase to £0.8 million per annum. Even greater

savings of £1.2 million per year would be achieved if the rate of exclusive breastfeeding at 4 months were to increase from the current 7% to 65%, the breastfeeding rate currently observed at birth.

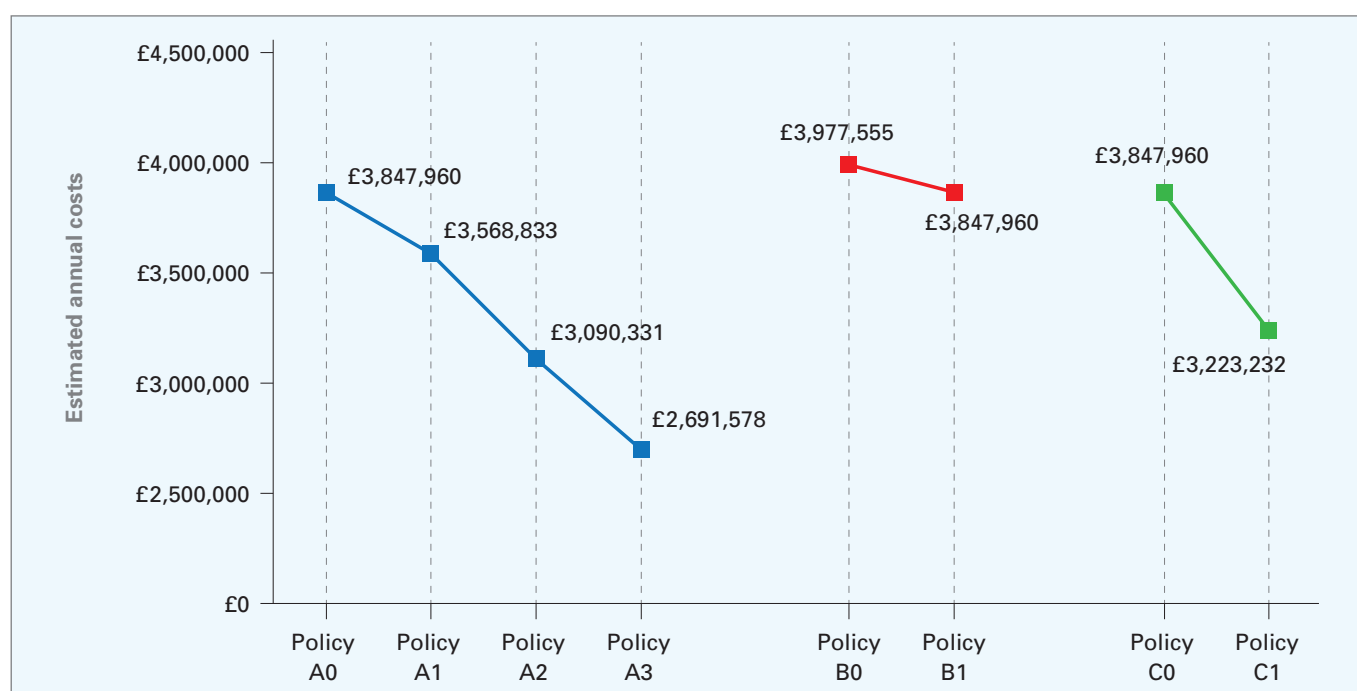
Table 19 also shows that the savings in primary care costs for acute otitis media in infants range from approximately 16p per infant if exclusive breastfeeding rates were to increase to 7% at six months, to £1.47 per infant if exclusive breastfeeding rates were to increase to 65% at four months.

Table 19: Estimation of potential savings per year in treating acute otitis media in infants less than one year old, due to increases in varying definitions of breastfeeding rates (refers to 788,486 infants' first year of life). For details of all model parameters and scenarios, see Section 3.4.2.1 and Appendices 2 and 10.

Odds ratios in favour of breastfeeding	Primary care costs	
	Estimate of potential cost-savings per annum	Potential saving per infant per year
Policy A1: increase exclusive breastfeeding at 4 months from current rate of 7% to 21%	£279,127	£0.35
Policy A2: increase rate of exclusive breastfeeding at 4 months to 45%	£757,629	£0.96
Policy A3: increase rate of exclusive breastfeeding at 4 months to 65%	£1,156,382	£1.47
Policy B1: increase rate of exclusive breastfeeding at 6 months to 7%	£129,595	£0.16
Policy C1: increase 'any breastfeeding' at 6 months to 48%	£624,728	£0.79

Figure 4 summarises how annual treatment costs of infantile AOM fall as the specified breastfeeding rate rises. The largest gain occurs when current exclusive breastfeeding rates are increased to the most optimistic scenario (that is, from current rate of 7% to 65%).

Figure 4: Fall in annual cost of treating otitis media following rises in exclusive or any breastfeeding (refers to 788,486 infants' first year of life, £ sterling). GP consultations only.



These figures indicate that using the mid-range policy scenario, 21,045 acute otitis media-related GP consultations would be averted.

Sensitivity analyses based on the range of odds ratios identified (Appendix 13) suggest that primary care cost savings related to treatment for otitis media might range from as little as £0.17 million to as much as £0.35 million if exclusive breastfeeding rates were to rise to 21% at four months, or from £0.7 million to as much as £1.5 million if the proportion exclusively breastfeeding were to increase to 65% at four months. Details of the sensitivity analyses are shown in Appendix 13.

Acute otitis media: summary

Nine systematic reviews and 3 UK studies were considered for use in our economic analysis. No corroborative evidence was identified. The sources considered to meet most closely the specifications required for modelling were Ip et al (2007) and Fisk et al (2011).

Economic analysis showed that approximately £280,000 per annum could be saved in primary care costs if the current exclusive breastfeeding rate at four months (7%) were to increase to 21%. Cost savings would increase to £750,000 per annum if the rate at four months increased to 45%, and £1.1 million per annum could be saved annually by increasing the rate to 65% at four months. Using the mid-range policy scenario, 21,045 acute otitis media-related GP consultations would be averted.



4.3.4 Economic analysis of necrotising enterocolitis (NEC) in infants in neonatal units

Table 20: Reviews and studies considered for use in calculating a summary statistic to inform economic modelling – necrotising enterocolitis (NEC)

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used for modelling ✓ whether used as corroborative evidence, or reasons not used
Systematic Reviews (n=5)		
Ip et al, 2007/2009	✓	Used as corroborative evidence. Uses older studies.
Barclay, 2007	Exposure not breastfeeding/feeding with breastmilk: no comparisons by infant feeding group	Not used
McGuire et al, 2003	✓	Used as corroborative evidence. Uses older studies.
Boyd, 2007	Included studies of lower quality than Quigley 2007a	Not used
Quigley et al, 2007a	✓	Used as corroborative evidence. Uses older studies.
UK studies (n=3)		
Lucas et al, 1990	✓	Used as corroborative evidence – included in Quigley et al, 2007
Henderson et al, 2009	✓	✓
Leaf et al, 2009	Paper does not report results.	Not used

Calculating the summary statistics to be used for economic modelling

Table 21 below shows the hierarchy of evidence used for necrotising enterocolitis for infants in neonatal units. For explanation of evidence hierarchy see Section 3.2.3 and Appendix 2, section 1.5.1. For details of methods and details of studies see the relevant data extraction forms (Appendix 11)

Table 21: Necrotising enterocolitis - hierarchy of evidence used for economic modelling. Details of these studies are shown in Appendix 11.

Primary source of evidence	Corroborative evidence
Henderson et al, 2009	Ip et al, 2007 McGuire et al, 2003 Quigley et al, 2007a Lucas et al, 1990

Table 22 below shows the odds ratios and confidence intervals used to inform economic analysis, derived from Henderson et al (2009), the primary source of data identified. Four sources of corroborative evidence were also identified. Full data on input parameters appear in Appendix 12.

Table 22: Necrotising enterocolitis in infants in neonatal units – input parameters used in economic analysis.

Odds ratios in favour of breastfeeding	Incidence	Unit costs (2009/10 prices)
Any breastmilk: 0.19 (0.05–0.73)	NEC cases: 1/100 neonatal admissions Surgical NEC: 31% Medical NEC: 69% Average length of stay: 26.7 days	Surgery: Baseline: £1,450 per episode Lower quartile: £689 Upper quartile: £1,802 Neonatal unit stay: Baseline: £618 per bed-day Lower quartile: £509 Upper quartile: £712

The figures in parentheses are 95% confidence interval.

Economic modelling: necrotising enterocolitis

Table 23 provides point estimates of treatment cost-savings that could be achieved each year from by increasing breastfeeding/breastmilk feeding rates in neonatal units. Approximately £2.3 million per year could be saved if the proportion of babies fed breastmilk in neonatal units were to increase from 35% to 50%. A further increase to 75% would increase savings in the cost of treating NEC to £6 million per annum. If the proportion of infants in neonatal units fed any breastmilk were to increase from the current 35% to 100% the cost of treating NEC could fall by as much as £10 million each year.

Table 23 also shows that the cost of each neonatal unit admission could be reduced by between £30 (if any breastmilk feeding at discharge increased to 50%) and £125 (if any breastmilk feeding at discharge increased to 100%).

Table 23: Estimation of potential savings per year in treating NEC in infants less than one year old, following increases in the rate of ‘any breastmilk feeding’ in neonatal units. For details of all model parameters and scenarios, see Section 3.4.2.1 and Appendices 2 and 10.

Policy Scenario	Total NEC cases per annum	Total treatment costs per annum	Annual cost-savings	Potential saving per neonatal admission
Policy D0: current practice – any breastmilk feeding at discharge: 35%	798	£13,535,618		
Policy D1: increase any breastmilk feeding at discharge to 50%	663	£11,240,325	£2,295,293	£29.02
Policy D2: increase any breastmilk feeding at discharge to 75%	437	£7,414,836	£6,120,782	£77.39
Policy D3: increase any breastmilk feeding at discharge to 100%	212	£3,589,347	£9,946,271	£125.75

Figure 5: Fall in annual cost of treating NEC in neonatal units following rises in rate of ‘any breastmilk feeding’ at discharge in neonatal units (refers to 79,094 neonatal admissions and 798 NEC cases in 2009/10, £ sterling).

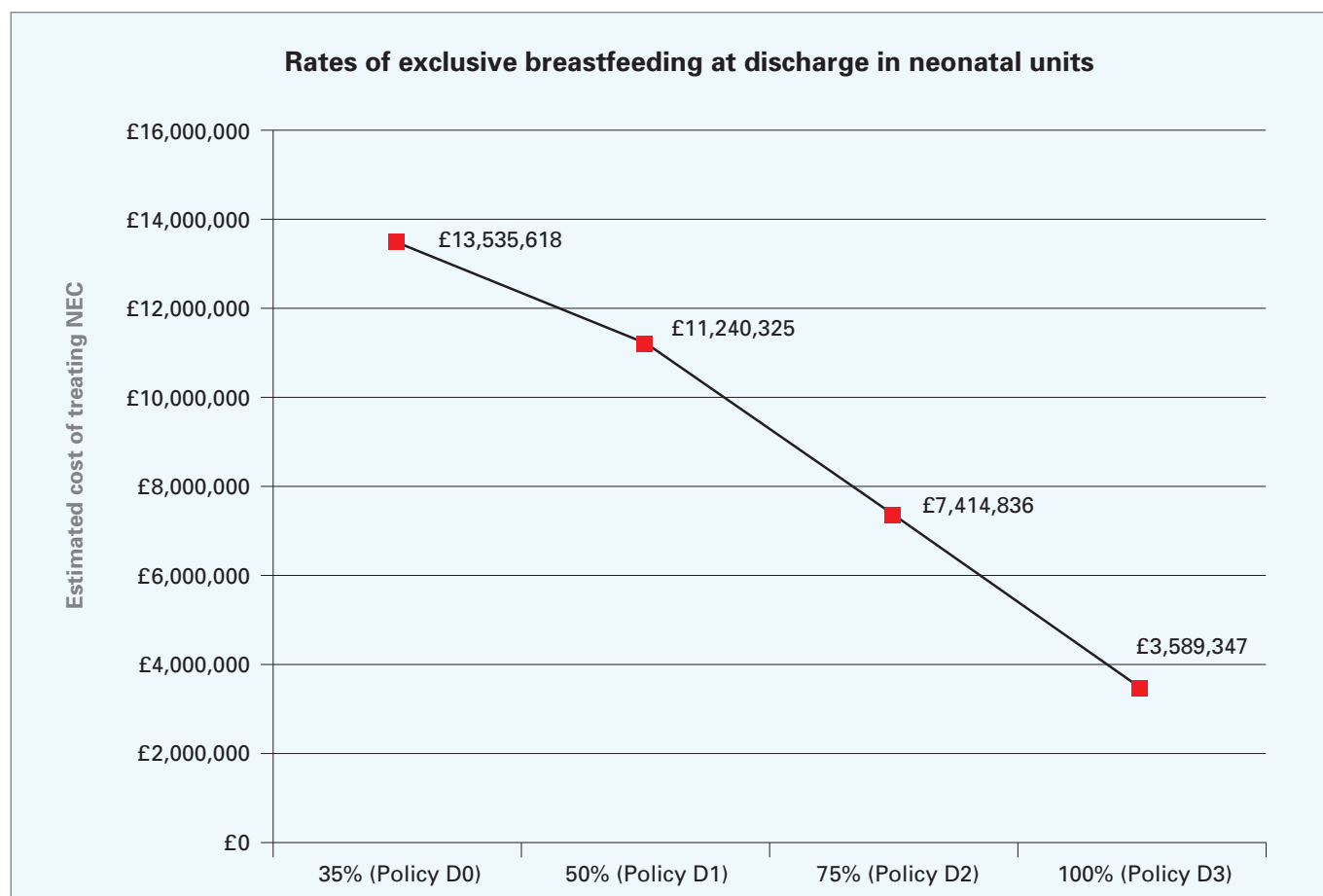


Figure 5 summarises how annual treatment costs of NEC fall as the specified breastfeeding rate rises. The largest gain occurs when the rates for 'any breastmilk feeding' are increased to the most optimistic level (that is, from the current rate of 35% at discharge, to 100% at discharge).

Sensitivity analyses based on the range of odds ratios identified (Appendix 13) suggest that cost savings related to treatment for NEC might range from a low of £0.61 million to a high of £2.9 million if breastfeeding/breastmilk feeding rates at discharge increased to 50%, and from £2.6 million to £10 million if rates rose to 100% at discharge from neonatal units.

We have not considered the economic consequences of the deaths caused by NEC in terms of QALYS; these would increase the economic implications considerably. The mortality rate associated with NEC is 15–30% (Lin et al, 2008).

Necrotising enterocolitis in infants in neonatal units: summary

Five systematic reviews and three UK studies were considered for use in this economic analysis. Data from three reviews and one UK study were used as corroborative evidence. The source considered to best meet the specifications required for this outcome was Henderson et al (2009).

Economic analysis showed that approximately £2.3 million per annum could potentially be saved in treating necrotising enterocolitis in infants in neonatal units by increasing the current rate of breastfeeding/breastmilk feeding at discharge from neonatal units from 35% to 50%. A further increase to 75% could increase savings to £6 million per year. Cost savings could increase to £10 million per annum if rates at discharge increased to 100%. The number of cases of NEC would fall from 798 to 212 per annum if all babies were breastfed/fed on breastmilk at discharge from neonatal units. This rate is currently achieved in some European and US units, for example Akerstrom et al (2007). This analysis does not include the economic consequences of lives lost to NEC, which are considerable.

4.3.5 Economic analysis of breast cancer in mothers

Table 24: Reviews, meta-analyses and studies considered for use in calculating a summary statistic to inform economic modelling – breast cancer in mothers.

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used for modelling ✓ whether used as corroborative evidence, or reasons not used
Systematic Reviews and meta-analyses (n=13)		
Ip et al, 2007/2009	✓	Not used
Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002	Does not report a summary statistic	✓ Individual patient data meta-analysis, large, good quality
Bernier et al, 2000	✓	Used as corroborative evidence – Collaborative Group on Hormonal Factors in Breast Cancer et al (2002) better for this purpose (larger, individual patient data analysis)
Lipworth et al, 2000	✓	Used as corroborative evidence – Collaborative Group on Hormonal Factors in Breast Cancer et al (2002) better for this purpose (larger, individual patient data analysis)
Ma et al, 2006	✓	Used as corroborative evidence – Collaborative Group on Hormonal Factors in Breast Cancer et al (2002) better for this purpose (larger, individual patient data analysis)
Yang and Jacobsen, 2008	✓	Used as corroborative evidence – Collaborative Group on Hormonal Factors in Breast Cancer et al (2002) better for this purpose (larger, individual patient data analysis)
Lee et al, 2008	Does not report numerical differences in breast cancer rates by infant feeding groups	Not used
Nagata et al, 1995	Does not report association between breastfeeding and breast cancer	Not used
Cohen et al, 2009	Does not report what infants were fed	Not used
Wigle et al, 2008	Does not report maternal breast cancer	Not used
Martin, 2005d	Does not report maternal breast cancer	Not used
Lopez-Cervantez et al, 2004	Does not report maternal breast cancer	Not used
Schack-Nielsen et al, 2005	Not a systematic review	Not used
UK studies (n=6)		
UKNCC 1993	✓	Not used, as only included women age under 36
Lowe and Macmahon, 1970	Old data	Not used
Press and Pharoah, 2010	Old data	Not used
Martin, 2005d	Old data	Not used
Perry et al, 2009	No numerical outcomes	Not used
Travis et al, 2010	Does not report association between breastfeeding and breast cancer	Not used

Calculating the summary statistics to be used for economic modelling

Table 25 below shows the hierarchy of evidence used for breast cancer in mothers. For explanation of evidence hierarchy see Section 3.2.3 and Appendix 2, section 1.5.1. For details of methods and details of studies see the relevant data extraction forms (Appendix 11).

Table 25: Breast cancer in mothers - hierarchy of evidence used for economic modelling. For details of all studies see Appendix 11.

Primary source of evidence	Corroborative evidence
Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002	Bernier et al, 2000 Lipworth et al, 2000 Ma et al, 2006 Yang and Jacobsen, 2008

Using data from the primary data source (Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002), and data from the sources outlined in Appendix 2, section 2.2.5, parameters for the economic modelling were identified. Table 26 below gives details of the input parameters for different lifetime durations of breastfeeding, derived from data presented in Collaborative Group on Hormonal Factors in Breast Cancer et al

(Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002). Four sources of corroborative evidence were also identified.

Unlike other outcomes examined in this report, this outcome applies to the mother's lifetime duration of all breastfeeding, rather than the amount of time each baby has been breastfed. Full data on input parameters in Appendix 12.

Table 26: Maternal breast cancer – input parameters used in economic analysis.

Odds ratios in favour of breastfeeding	Incidence	Unit costs (2009–10 prices)
<p>Ever breastfeeding vs. never breastfeeding: 0.96 (0.92–0.99)</p> <p>Breastfeeding for <6 months v never: 0.98 (0.95–1.01)</p> <p>Breastfeeding for 7-18 months v never: 0.94 (0.91–0.97)</p> <p>Breastfeeding for 18+ months v never: 0.89 (0.84–0.94)</p>	<p>Breast cancer cases:</p> <p>Lifetime incidence of 12,500/100,000 population (that is a lifetime risk of 1 in 8)</p>	<p>Breast cancer average:</p> <p>Baseline: £11,726 per case</p> <p>Upper end cost: £16,260</p>

The figures in parentheses are 95% confidence interval.

Economic modelling: breast cancer in mothers

The expected impact on the costs of treating women with breast cancer following changes in breastfeeding patterns are presented as potential cost-savings.

Table 27 provides point estimates of the reduced costs of treating maternal breast cancer in the UK if breastfeeding rates increased from current levels. Results show that over £15 million per 313,817 first-time mothers could be saved in breast cancer treatment costs over their lifetime, if half of the women who currently do not breastfeed were enabled to breastfeed for up to six months in their lifetime. If the proportion of those 'never-breastfeeding' were halved, and 32% of women were enabled to breastfeed for a lifetime total of 7–18 months, the predicted savings from breast cancer would be over £21 million per 313,817 first-time mothers, over their lifetime. Cost savings would rise to almost £28 million per 313,817 first-time mothers over their lifetime if the proportion never breastfeeding (32%) were halved (to 16%) and the number of parous women breastfeeding for 18+ months were doubled from 16% to 32%. Policy E1 aims at halving the percentage of mothers who 'never breastfeed' (from 32% to 16%) and increasing the number of mothers who breastfeed for ≤ 6 months over their lifetime by 16 percentage points (from 36% to 52%).

Table 27 also shows the number of cases of breast cancer that could be avoided under different policy scenarios per 313,817 first time mothers over their lifetime. These range from 627 if 52% of women could be supported to breastfeed for up to six months in their lifetime, to 1,136 if 32% of women could be enabled to breastfeed for more than 18 months in their lifetime.

As well as the financial savings from reduced incidence of disease, it is important to capture health impacts that result from the avoidance of breast cancer. These are quantified in terms of QALYs that consider life years gained and improvements in quality of life that might be gained as a result of avoiding breast cancer (National Institute for Health and Clinical Excellence, 2008 – see Appendix 2, section 2 for explanation. Table 27 estimates that 371 QALYs would be gained across the lifetime of 313,817 first-time mothers, if half of those who are not breastfeeding currently were supported to breastfeed for up to six months in their lifetime. If the current 'never breastfeeding' rate were halved and the breastfeeding rate for 7–18 months increased to 32%, the predicted annual QALY gains would be about 512. The scenario with the highest potential QALYs gained (673 QALYs per 313,817 first time mothers over their lifetime) could be achieved by moving from 32% 'never breastfeeding' to a position that halves this rate and doubles the number of women breastfeeding for 18+ months from 16% to 32%. At £20,000 per QALY threshold, these QALY gains, when combined with savings from treatment costs, offer an incremental benefit of about £23 million, £31 million and £41 million per 313,817 first-time mothers over their lifetime, respectively.

Economic gains would, of course, be greater if breastfeeding rates increased further.

Table 27: Estimated potential benefits from reducing maternal breast cancer (refers to a cohort of 313,817 primiparous women* over their lifetime). Current policy scenarios are fully described in Section 3.4.2.1 and Appendices 2 and 10.

Policy options	Expected breast cancer cases over cohort lifetime	Cancer cases avoided over cohort lifetime (relative to Policy E0)	Incremental QALYs gained over cohort life time	Treatment costs saved over cohort life time	Value of QALYs gained over cohort lifetime	Incremental benefit** over cohort lifetime
Policy E0: current rates (that is, 32% never breastfeed; 36% ≤6 months; 16% 7-18 months; 16% 18+ months)	39,227	-				-
Policy E1: Half of never breastfed women breastfeed for ≤ 6 months (that is, 16% never breastfeed; 52% ≤6 months; 16% 7-18 months; 16% 18+ months)	38,600	627	371	£15,336,495	£7,424,663	£22,761,158
Policy E2: Half of never breastfed women breastfeed for ≤ 18 months (that is, 16% never breastfed; 36% ≤6 months; 32% 7-18 months; 16% 18+ months)	38,362	865	512	£21,171,335	£10,249,410	£31,420,745
Policy E3: Half of never breastfed women breastfeed for 18+ months (that is, 16% never breastfeed; 36% ≤6 months; 16% 7-18 months; 32% 18+ months)	38,091	1136	673	£27,800,286	£13,458,600	£41,258,886

*Estimated by multiplying the number of live births (788,486) in the UK (ONS 2009) by proportion of primiparous women (39.8%) in the UK (EURO-PERISTAT Project, 2008).

**Incremental benefit defined as the difference in total loss (that is, sum of treatment costs and the value of QALYs lost) between baseline (Policy E0) and the new scenario (Policy E1 or E2 or E3).

Figure 6 summarises how the number of maternal breast cancer cases fall (and therefore incremental benefit rises) as the rate of women never-breastfeeding declines. The scenario with the largest gain would be if the number of women who never-breastfeed was to be halved and the breastfeeding rate for 18+ months were doubled.

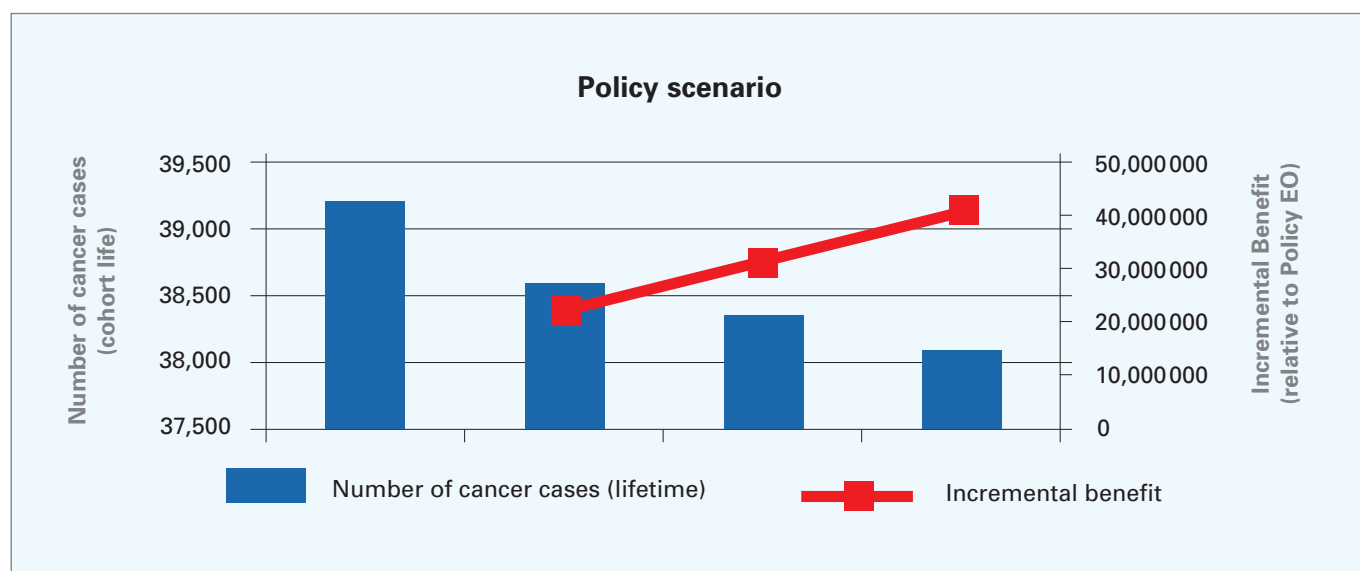


Figure 6: Fall in number of breast cancer cases and corresponding incremental benefit values assuming different rises in breastfeeding rates (refers to 313,817 primiparous women; time horizon: lifetime; £ sterling).

Sensitivity analyses based on the range of odds ratios identified (Appendix 13) suggest that lifetime cost savings related to treatment for breast cancer might range from £6 million to a high of £40 million for an annual cohort of 313,817 primiparous women if the number of mothers 'never breastfeeding' reduced to 16%, and 52% of mothers were supported to breastfeed for up to 6 months in their lifetime; and from £19 million to £64 million for a cohort of 313,817 primiparous women if the number of women 'never breastfeeding' reduced to 16%, and 32% of women were supported to breastfeed for 18+ months in their lifetime.

Breast cancer in mothers: summary

Thirteen systematic reviews and meta-analyses and six UK studies were considered for use in this economic analysis. Data from four reviews were used as corroborative evidence. The source considered to meet most closely the pre-set requirements for modelling this outcome was a large meta-analysis

of individual patient data (Collaborative Group on Hormonal Factors in Breast Cancer et al, 2002).

Economic analysis showed that lifetime benefits are approximately £15 million saved in the treatment of breast cancer, 627 breast cancer cases avoided, and 371 QALYs gained per annual cohort of around 313,000 women giving birth to their first baby (equivalent to an incremental benefit of around £23 million), by reducing the proportion of women who never breastfeed from 32% to 16% whilst supporting 52% of women to breastfeed for a total lifetime period of 6 months.

Lifetime cost savings to the health service could be increased to around £21 million per annual cohort of around 313,000 women, by reducing the proportion of women who never breastfeed to 16%, whilst supporting 32% of women to breastfeed for up to 18 months of their lives. In such a scenario, 865 breast cancer cases would be avoided, and 512 QALYs gained, equivalent to a incremental benefit of over £31 million per annual cohort of 313,000 women over their lifetime.

4.4 Summary of costs of all five economic models

Table 28 to Table 30 below show the estimated annual cost savings, for each of the three main policy scenarios, of the five diseases for which we developed economic models. The four acute diseases in infants would result in short-term savings from treatment costs, while savings from avoiding breast cancer cases would accrue over the lifetime of each annual cohort of first time mothers; as would the breast cancer-related QALYs gained.

Using the least optimistic policy scenarios (increasing exclusive breastfeeding to 21% at four months, and 35% of babies breastfeeding at discharge from neonatal units), a total of around £6.37 million could be gained annually by avoiding the costs of treating the four acute diseases in infants. A further £15 million would be saved from the costs of treating breast cancer over the lifetime of each annual cohort of first-time mothers if 16% of women breastfed for 18+ months in their lifetime, and the value of breast-cancer QALYs gained for each annual cohort would be around £7.4 million.

Using the most optimistic policy scenarios (increasing exclusive breastfeeding to 65% at four months, and 100% of babies breastfeeding at discharge from neonatal units), a total of around £26.8 million could be gained annually by avoiding the costs of treating the four acute diseases in infants. A further £28 million would be saved from the costs of treating breast cancer over the lifetime of each annual cohort of first-time mothers if 32% of women breastfed for 18+ months in their lifetime, and the value of breast-cancer QALYs gained for each annual cohort would be around £13.4 million.

Even the most optimistic policy scenarios were set at realistic levels, and have taken into account rates achieved in other European countries – for example, Sveriges officiella statistik och Socialstyrelsen (2009) and Lande et al (2003). Greater economic gains would be made were rates to exceed these levels.

Table 28: Results of economic models of acute disease in infant – estimated annual savings from avoiding costs of disease, UK: Savings from costs of treatment for all diseases.

Acute disease in infants	Annual savings from least optimistic policy scenarios	Annual savings from mid-level policy scenarios	Annual savings from most optimistic policy scenarios
Gastrointestinal infection in infants	£1.34 million	£3.6 million	£5.54 million
Respiratory tract infection in infants	£2.45 million	£6.7 million	£10.15 million
AOM in infants	£279,000	£757,000	£1.16 million
NEC, infants in neonatal units	£2.3 million	£6.12 million	£10 million
Total annual savings from acute disease in infants	£6.37 million	£17.18 million	£26.85 million

Table 29: Results of economic model of breast cancer in mothers – estimated savings in treatment costs from avoiding costs of disease over the lifetime of an annual population of 313,817 primiparous women, UK.

Breast cancer in mothers	Cost savings over lifetime of <i>each</i> annual cohort from least optimistic policy scenarios	Cost savings over lifetime of <i>each</i> annual cohort from mid-level policy scenarios	Cost savings over lifetime of <i>each</i> annual cohort from most optimistic policy scenarios
Breast cancer in mothers	£15 million	£21 million	£28 million

Table 30: Results of economic model of breast cancer in mothers – estimated breast cancer cases averted with number and value of lifetime QALYs gained over the lifetime of an annual population of 313,817 primiparous women, UK (valued at £20,000/QALY).

Breast cancer in mothers	Least optimistic policy scenarios	Mid-level policy scenarios	Most optimistic policy scenarios
Breast cancer cases averted	627	865	1136
QALYs gained	371	512	673
Value of QALYS gained <i>per annual cohort</i>	£7.4 million	£10.2 million	£13.4 million

These cost savings should be set against the costs required to increase breastfeeding rates; this is discussed in Section 5.3.

4.5 Outcomes where a quantified approach was not possible

Our reviews of disease and developmental outcomes identified a number of conditions associated with ‘not breastfeeding’ where the evidence is of good quality, and which have potentially large economic consequences, but where these could not be feasibly quantified. The reasons included uncertainty about the size of association between breastfeeding and the condition, an absence of reliable evidence on the economic impact of the condition, the complexity of the economic modelling exceeding the scope of this

study, and a substantial part of the burden of costs falling on sectors other than the health services. The limitations of current evidence are similar to other public health questions.

It is nevertheless important that the economic impacts associated with these outcomes are not overlooked. Although there is significant uncertainty about the proportion of treatment costs in these conditions that might be saved by increasing the prevalence of breastfeeding, the amounts might significantly outweigh those estimated in earlier sections, in part because costs are accrued over an individual’s whole life.

Throughout this section on narrative analyses, costs have not been discounted.

4.5.1 Cognitive outcomes: the economic consequences associated with not breastfeeding

Evidence identified: cognitive outcomes

Table 31 below shows the studies considered for use in our economic analysis of cognitive outcomes.

Table 31: Reviews and studies considered to identify optimum evidence – cognitive outcomes.

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used for modelling ✓ whether used as corroborative evidence, or reasons not used
Systematic Reviews (n=4)		
Ip et al, 2007/2009	✓	Not used: included studies heterogeneous with respect to exposure (breastfeeding/breastmilk feeding) and outcome (what outcomes were measured, when and how), and are not from the UK.
Horta et al, 2007	✓	Not used: same data included in more recent review (Ip et al)
Anderson et al, 1999	✓	Not used: same data included in more recent review (Ip et al)
Drane 2000	✓	Not used: same data included in more recent review (Ip et al)
UK studies (n=5)		
Quigley et al, 2012	✓	✓ Large study, reports term and pre-term infant separately
Iacovou and Sevilla-Sanz, 2010	✓	Does not report term and preterm infants separately. Relevant good quality evidence to consider
Holme et al, 2010	Outcome reporting not appropriate. Large proportion of smokers in sample.	Not used.
Rodgers, 1978	Older data	Not used
Lucas et al, 1984	No comparisons between infants who did and did not receive human milk.	Not used

Table 32 below shows the sources with the most relevant evidence for the UK. We identified one primary source of data (Quigley et al, 2012), and one other source of relevant good quality evidence.

Table 32: Summary of evidence used for cognitive outcomes.

Primary source of evidence	Other studies with relevant good quality evidence
Quigley et al, 2012	Iacovou et al, 2010

Table 33: Summary of data from primary source of evidence, cognitive outcomes (full results shown in Appendix 11).

Primary source of evidence	Summary of relevant findings
Quigley et al, 2012	<p>"After adjusting for confounders, there was a significant difference in mean score between those breastfed and those never breastfed:</p> <ul style="list-style-type: none"> • in term children, a 2-point increase in score for picture similarities (if breastfed for ≥ 4 months) and naming vocabulary (if breastfed for ≥ 6 months) • in preterm children, a 4-point increase for naming vocabulary (if breastfed for ≥ 4 months) and picture similarities (if breastfed for ≥ 2 months) and a 6-point increase for pattern construction (if breastfed for ≥ 2 months) <p>These differences suggest that breastfed children will be 1–6 months ahead of children who were never breastfed."</p>

Narrative assessment of the impact of not breastfeeding on cognitive outcomes

Whilst earlier reviews were sceptical about the quality of the evidence and in particular the ability to control for confounding variables (Ip et al, 2007), there is a growing body of well-designed studies that explore the association between breastfeeding and cognitive outcomes. They conclude that increasing both the proportion of infants who are breastfed and the duration of breastfeeding are associated with improved cognitive outcomes (Quigley et al, 2012; Iacovou and Sevilla-Sanz, 2010).

Accurately estimating the effect of breastfeeding on cognitive and related outcomes is inherently challenging. It demands: access to longitudinal cohort data over a significant period; accurate, preferably prospective, measurement of feeding behaviours; and comprehensive data on a number of potential confounders, most notably measures of maternal cognitive ability. Most evidence points to a positive correlation with breastfeeding, but the magnitude of the impact remains uncertain. One reason for this is the low prevalence of exclusive breastfeeding in developed countries: most children tested will have received some breastmilk substitute even if described in the studies as breastfed. This may dilute the potential effect of breastfeeding.

Another methodological challenge is the inconsistency in the methods used to measure cognitive and developmental abilities in the absence of an internationally accepted approach. Studies have measured outcomes as varied as IQ, test scores in reading, writing and maths, naming vocabulary, and pattern construction. A number of international studies have reported improvements in IQ levels of 5–6 points in children who are breastfed compared to those who are not (Kramer et al, 2008; Oddy et al, 2003). A meta-analysis by Anderson et al (1999) indicates that these differences persist once confounding factors, such as maternal age, education and IQ, are taken into account. Meta-analysis is complicated by differing approaches to measuring cognitive outcomes and different definitions of breastfeeding. However, the Anderson study indicates that an unadjusted increment of approximately five points resulting from breastfeeding is reduced to around three points

after adjustment for confounders and, importantly, remains statistically significant.

The most recent study from the UK adopted a battery of measures, including the British Ability Scales (BAS) which assess vocabulary, pictorial reasoning and spatial abilities (Quigley et al, 2012). These suggest that the mean scores for all sub-scales increased with duration of breastfeeding even after adjustment for confounders. The effects were even more marked in children born pre-term.

Previous commentators have recognised that effects on cognitive outcomes are associated with economic consequences (Phelps, 2011), although to our knowledge there have been no attempts to quantify these in financial terms (Phelps, 2011). Whilst the gains in cognitive ability reported above might be considered to be relatively modest, these can have significant and long-lasting financial impacts as well as broader societal impacts. The most obvious outcome is an impact on educational attainment levels that, in turn, is associated with an impact on lifetime earnings. In order to estimate the magnitude of this effect, one can draw on evidence from the field of environmental economics.

A number of studies have sought to identify the economic impacts of environmental pollutants that might impact on the cognitive development of children. The most notable body of evidence relates to legislation to control exposure to harmful levels of lead in the environment in the United States. Needleman and Gatsonis (1990) undertook a rigorous meta-analysis of the evidence on lead exposure and the IQ of children, and concluded that there was strong support for the hypothesis that exposure to low levels of lead can impair children's IQ. Grosse et al (2002) estimate that legislation to reduce blood lead levels in the United States between the late 1970s and the late 1990s led to an increase in average IQ levels of 2.2–4.7 points. Furthermore, these authors went on to estimate the financial effects of these changes, arguing that for each one point increase in IQ, worker productivity increases by between 1.76–2.38% (base case assumed to be 2%). Applying this to estimated lifetime earnings suggested that a one point increase in IQ would result in an improvement in lifetime earnings of

approximately US\$14,500 (range US\$12,700–17,200) and that legislation to reduce exposure to lead would result in an increase in lifetime earnings of approximately US\$56,100 (note all figures reported in US\$ prices in year 2000).

To put these into a UK context, estimates from the Learning and Skills Council in 2007 suggest that lifetime earnings range from £873,392 for an individual with no formal educational qualifications to £1,819,792 for an individual with a degree or higher qualification. Table 34 below reports the findings of applying the earnings with IQ ratio adapted by Grosse et al (2002) to these estimates of lifetime earnings. We used a conservative assumption, derived from the studies included in this section, that breastfeeding for a minimum of 2–3 months leads to an increment of 1–2 points in IQ compared to not breastfeeding.

Table 34: Estimated impact of a 1–2 point increase in IQ on lifetime earnings (2007 prices).

Assumed increase in IQ	Estimated increment to lifetime earnings (2007 prices)	
	No formal educational qualifications	Degree or higher qualification
1 point increase in IQ	£17,468	£36,396
2 point increase in IQ	£34,936	£72,792

Our estimates suggest that breastfeeding for a minimum of 2–3 months might add between £17,000 and £72,000 to lifetime earnings. More prolonged breastfeeding is expected to lead to greater increments in IQ levels as studies included here have found evidence of dose-response effect. These estimates are presented at an individual level; scaling them to a population level would lead to more marked potential gains to the economy as a whole. We have considered the economic implications of this at a national level, using very conservative assumptions based on the evidence presented in this section, as follows:

Table 35: Estimated economic implications of adverse cognitive effect in the UK.

Number of live births in 2009 – adjusted for neonatal (28 days) mortality	788,486 (ONS)
% never breastfed	19% (Infant Feeding Survey 2010)
Number never breastfed	149,886
Adverse cognitive effect resulting from this	2 IQ points (assumed as above)
Lifetime income losses that result from adverse cognitive effect	£34,936 per individual never breastfed

If the proportion of never breastfeed infants were to decrease by only 1%, from 19% to 18%, the resultant estimated impact would be:

- 7,959 fewer children who experience a reduction in potential IQ , resulting in
- circa £278 million gains in economic productivity

These economic losses are projected solely on the number of births in the 2009 birth cohort and would be cumulative annually, suggesting that costs over a longer period could be substantial. This scenario has only considered decreasing the proportion of never breastfed infants by one percentage point. Increasing the duration of breastfeeding for those who start to breastfeed would bring additional benefits.

Whilst impact on lifetime earnings is clear, other financial and non-financial impacts also need to be considered. Some studies have suggested that lower incidence and shorter durations of breastfeeding might be associated with greater prevalence of later behavioural problems compared to more prolonged breastfeeding, for example Heikkilä et al (2011). These may have further consequences for a child's schooling as well as family relationships and social functioning, requiring more intensive teaching and leading to exclusion from activities. Establishing a causal link between breastfeeding and such outcomes is challenging, but changing early feeding behaviours at least has the potential to modify an individual's social skills, personal development and family life. This should be considered in the context of other early years interventions that have long term impact on children and families (Heckman and Masterov, 2004; Sinclair, 2007).

4.5.2 Sudden Infant Death Syndrome (SIDS): the economic consequences associated with not breastfeeding

Evidence identified: Sudden Infant Death Syndrome

Table 36 below shows the studies considered for use in our economic analysis of SIDS.

Table 36: Reviews and studies considered to identify optimum evidence - Sudden Infant Death Syndrome.

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used ✓ or reasons not used
Systematic Reviews (n=1)		
Hauck et al, 2011	✓ Good quality meta-analysis. Deals with confounders. The effect size is strengthened by duration of breastfeeding (as measured at 2 months) and exclusivity.	✓
UK studies (n=2)		
Tappin et al, 2005	Examined sleeping surface. Infant feeding not defined or measured.	Not used
Blair et al, 2006	Examined sleeping position. Infant feeding not measured/defined.	Not used

Table 37 below shows the most relevant sources of data for the UK. We identified one primary source of data: a good quality meta-analysis by Hauck et al (2011).

Table 37: Summary of evidence used for Sudden Infant Death Syndrome.

Primary source of evidence	Alternative sources of relevant evidence
Hauck et al, 2011	None

Table 38: Summary of data from the primary source of evidence – Sudden Infant Death Syndrome. Full details appear in Appendix 11.

Primary source of evidence	Relevant data
Hauck et al, 2011	<p>For infants who received any amount of breastmilk for any duration, the univariable SOR was 0.40 (95% confidence interval [CI]: 0.35–0.44), and the multivariable SOR was 0.55 (95% CI: 0.44–0.69).</p> <p>For any breastfeeding at 2 months of age or older, the univariable SOR was 0.38 (95% CI: 0.27–0.54).</p> <p>The univariable SOR for exclusive breastfeeding of any duration was 0.27 (95% CI: 0.24–0.31).</p>

Narrative assessment of the impact of not breastfeeding on SIDS

Of all the outcomes associated with *not* breastfeeding, SIDS might be considered the most catastrophic. The paradox is that from a purely financial perspective, SIDS is one of the least costly outcomes. A ‘burden of illness’ approach would treat SIDS as an event associated with relatively modest, one-off costs to the NHS. This is revealed in the unit cost allocated to individuals who are ‘dead on arrival’ at hospital, amounting to just £87 in the 2009–10 NHS Reference Costs. Whilst there may be some additional costs (for example, transportation, death certification and bereavement support), the overall cost of an infant death to the health service is very low when compared with that associated with a chronic illness of lifelong duration.

It is inappropriate, however, to focus on monetisation given the profound effect that SIDS has on families following the loss of their baby and so a broader perspective on SIDS has been taken. These indirect costs might be summarised as:

- The emotional burden (suffering, loss of well-being) on family members
- Loss of life years as a consequence of premature death
- Loss of lifetime productivity to the economy associated with premature death

- Financial impact on family members (for example, as a result of lost productivity through grief)
- Health and social care costs associated with the need to support the family.

There are methods available to estimate these costs. Individuals can be viewed economically as ‘human capital’; that is, a means of production that can be economically valued as such. This approach does not, however, account for pain and suffering associated with an outcome such as SIDS, and also fails to allow for societal preferences to avoid such events. These aspects are better addressed by adopting techniques such as “willingness to pay” estimation that are typically adopted to examine the value placed on averting events such as SIDS. This technique involves asking groups how much they would be willing to pay (hypothetically) to reduce the risk of SIDS from x to y . Whilst the questions can be developed in such a way to elicit accurate and sensible responses, ultimately these techniques rely on the hypothetical, as individuals are aware that they will not be required to make any actual payment. As such, there may be the potential for individuals to overstate their willingness to pay, particularly for the avoidance of highly emotive events such as infant deaths. Such techniques are infrequently used in economic studies of health care in the UK.

There are relatively few studies that have sought to quantify the impact of SIDS in relation to infant feeding. In their analysis of the burden of sub-optimal breastfeeding, (Bartick and Reinhold, 2010) estimated the cost of a death at US\$10.56 million, referring to a previous study (Weimer, 2001) that adopted a 'labour-market' approach based on the higher wages demanded for riskier jobs. The same value was applied to infant deaths resulting from SIDS or NEC, and to deaths in later life, for example as a result of type 1 diabetes.

Given the paucity of evidence, alternative approaches to valuing the impact of breastfeeding on SIDS are required. Health technology assessments conducted by the National Institute of Health and Clinical Excellence adopt a threshold value for an additional quality adjusted life year (QALY) of between £20,000–£30,000 (National Institute for Health and Clinical Excellence, 2008). Assuming that this is a fair reflection of the value that society places on a life year in full health, and that this value does not discriminate by age, this figure could be applied to value loss of life as a result of SIDS. Taking a mean life expectancy at birth of around 80 years and average population quality of life of around 0.8,

a newborn could be expected to accrue 64 years of life in full health. Premature death during the first full year of life would thus result in a loss of between £1.28 million–£1.92 million (undiscounted).

Another option might be to apply Her Majesty's Treasury value of £1,585,510 million per fatality avoided (Department for Transport, April 2011). This figure was originally devised for use in studies of transport safety, but has been presented in Treasury guidance intended to inform the evaluation of public sector programmes more generally.

We have applied these costs to estimate the economic implications of SIDS at a national level, using very conservative assumptions (Table 39).

To illustrate the impact that this might have at national level; based on the studies included in this section, it is a reasonable expectation that even a modest increase in exclusive breastfeeding for more than two months could result in a 1% reduction in the incidence of SIDS. If this was the case, at least three cases of SIDS would be avoided, preventing a monetary loss of approximately £4.7 million as well as avoiding the profound consequences for families.

Table 39: Illustrative example of the scale of the economic implications of SIDS in the UK.

Number of SIDS* 2009	279 in England & Wales (ONS, 2011)
Extrapolated to UK population	315 (Iacovou et al, 2010)
Rate of SID	0.4/1,000 live births (ONS)
Value of statistical life	£1,585,510 (Department for Transport, April 2011)
Value of lives lost to SIDS	£499,435,650

4.5.3 Childhood obesity: the economic consequences associated with not breastfeeding

Evidence identified: childhood obesity

Table 40 below shows the studies considered for use in our economic analysis.

Table 40: Reviews and studies considered to identify optimum evidence – childhood obesity.

Reviews and studies identified in searches	Considered for modelling ✓ or reasons not considered	Used ✓, whether used as other source of relevant evidence, or reasons not used
Systematic Reviews (n=8)		
Horta et al, 2007	✓	✓
Ip et al, 2007/2009	Does not report a summary statistic	Not used
Arenz et al, 2004	Finds evidence of association	Not used - included in Horta et al
Owen et al, 2005a	Finds evidence of association	Not used - Included in Horta et al
Owen et al, 2005b	Finds no evidence of association	Not used - included in Horta et al
Huang, 2009	Not a systematic review, does not report a summary statistic	Not used
Smith and Harvey, 2010	Economic evaluation for Australia with effectiveness data based on Horta 2007	Not used
Harder et al, 2005	Lack of control for confounders	Not used
UK studies (n=6)		
Wilson et al, 1998	✓	Used as other source of relevant evidence: exposures, control for confounders, outcome measures and outcomes differ
Armstrong and Reilly, 2002	✓	Used as other source of relevant evidence: exposures, control for confounders, outcome measures and outcomes differ
Parsons et al, 2003	Old data – offspring of 1958 birth cohort	Not used
Li et al, 2003	✓	Used as other source of relevant evidence: exposures, control for confounders, outcome measures and outcomes differ
Reilly et al, 2005	✓	Used as corroborative evidence: exposures, control for confounders, outcome measures and outcomes differ
Griffiths et al, 2009	Looked at weight gain rather than obesity	Not used

Table 41: Summary of evidence used for childhood obesity.

Primary source of evidence	Other sources of relevant evidence
Horta et al, 2007	Armstrong and Reilly, 2002; Li et al, 2003; Reilly et al, 2005; Wilson et al, 1998

Table 42: Summary of data from the primary source of evidence – childhood obesity. Full details appear in Appendix 11.

Primary source of evidence	Summary of relevant findings
Horta et al, 2007	From 39 estimates of the effect of breastfeeding on prevalence of overweight/obesity: in a random-effects model, breastfed individuals were less likely to be considered as overweight and/or obese, with a pooled odds ratio of 0.78 (95% CI: 0.72–0.84). Control for confounding, age at assessment, year of birth, and study design did not modify the effect of breastfeeding. Because a statistically significant protective effect was observed among those studies that controlled for socio-economic status and parental anthropometry, as well as with >1,500 participants, the effect of breastfeeding was not likely to be due to publication bias or confounding.'

Narrative assessment of the impact of not breastfeeding on childhood obesity

The increasing prevalence of obesity in the UK is widely recognised. The most recent data on childhood obesity in England are derived from the National Child Measurement Programme conducted in 2010 (Department of Health, 2011). This suggests that 31% of boys and 29% of girls age 2–15 are obese or overweight. In younger children age 4–5, obesity prevalence was just below 10%. There is a recognition that many children who are obese will continue to be so in adulthood though the exact proportion is not clear. The Foresight report *Tackling Obesity* (McPherson et al, 2007) estimates that a child who is obese age 1–2 years is 30% more likely to be obese as an adult. This ratio increases markedly with age and the degree of obesity. Although there are signs that the rate of increase in childhood obesity is reducing (Stamatakis et al, 2010), the prevalence of adult obesity in future generations is expected to rise as a consequence of trends in childhood.

The impact of obesity on public expenditure has been well documented. The cost of obesity and

related conditions to the NHS is estimated to be in excess of £4 billion (Department of Health, 2008) although this represents only part of the total cost to society as a whole. The Foresight report (2007) estimates that current trends in obesity, if not arrested, would cost the UK economy £50 billion by 2050. The direct costs of treating obesity, for example through pharmacological or surgical approaches, are actually relative modest. Evidence from the Counterweight programme identified that obesity increases prescription costs for obesity and related conditions as well as GP consultations (McQuigg et al, 2008). However, the real economic impact of obesity is associated with the increased risk of developing weight-related conditions over a lifetime. For example, obesity is associated with an increased risk of developing type 2 diabetes, hypertension and coronary heart disease (McPherson et al, 2007). There is also an increased risk of certain cancers, including colon cancer and breast cancer (McPherson et al, 2007). Obesity is also associated with increased risk of musculoskeletal disease and depression (McPherson et al, 2007).

Quantifying the effect of infant feeding behaviour on obesity and its associated costs is challenging. Obesity is affected by a number of factors, and controlling for confounding variables is a particular challenge: for examples of this debate, see Brion et al (2011), Daniels and Adair (2005), Owen et al (2005).

Much evidence suggests that *not* breastfeeding is associated with an increased risk of obesity in later childhood, although the methods used to estimate the effect size are open to some criticism. One meta-analysis (Horta et al, 2007) reports an odds ratio for later obesity according to breastfeeding history, stratified into high-income and medium/low income countries. Evidence from studies performed in high-income countries points to a strong association between not breastfeeding and adult obesity, with a statistically significant odds ratio of 0.77. However, many of the data were acquired outside the UK and the meta-analysis combined studies that defined breastfeeding only as “ever/never” with those that measured exact durations of breastfeeding. Caution needs to be exercised in interpreting this evidence.

A further difficulty is identifying the duration of any protective effect of breastfeeding. This is important in estimating the proportion of obesity cases that might be attributed to *not* breastfeeding as opposed to the numerous other contributory factors. For example, it might hypothetically be assumed that a protective effect of breastfeeding lasts for the duration of breastfeeding and a relatively short period afterwards. On this basis, breastfeeding might only impact cases of obesity that occur before the age of two years. To determine the potential cost benefits, it would be necessary to calculate both the age of onset of obesity and the proportion of obese very young children who will be obese adults. This is not possible at present. Assuming that the beneficial impact of breastfeeding might continue for the rest of the child’s life would markedly, and perhaps erroneously, overestimate the impact and financial consequences, of obesity among those not breastfed.

Calculating the economic benefits of breastfeeding would also require an age-standardised estimate of the cost of treating obesity. If a lifetime perspective were adopted, recognising that the majority of the costs are associated with long-term complications,

age-adjusted risk ratios for developing weight-related conditions over the course of an individual’s life would be required. This also would require more data not currently available and development of a complex simulation model of the type conducted in the Foresight report (McPherson et al, 2007).

Whilst it is unrealistic to make accurate estimates, it is possible at least to put the potential costs into context. The 2001 UK Census (Office for National Statistics, 2002) estimates that there were 3,486,469 children age less than 4 years. Applying data on the rates of obesity from the 4–5 year cohort in the National Children’s Measurement Programme (Department of Health, 2011) reported above (9.4%), suggests that there were 327,728 obese children. Studies from the United States have estimated an annual incremental health care cost of between US\$170–300 for obese children compared to children of normal weight (Trasande and Chatterjee, 2009). If a conservative incremental cost for the UK is assumed, based on the above figures, of £100 per child per year, this equates to a cost to the health service in excess of £32 million per year.

Horta et al (2007) conclude that breastfeeding may offer a “small protective effect on the prevalence of obesity.” On this basis, we have assumed that increased rates of breastfeeding might offer the potential to reduce childhood obesity by 5%, then:

- the number of obese young children would fall by approximately 16,300, and
- annual health care expenditures would reduce by circa £1,630,000 per year.

These figures are merely illustrative and must be interpreted with caution. They take no account of the lifetime costs that might result from cost savings extending into adulthood. This would increase substantially the cost savings that would accrue if breastfeeding were more prevalent. Nor do these figures capture the broader impacts of obesity, including the impact on well-being, life expectancy and the economy as a whole. It is difficult to quantify these impacts but such broader societal costs need to be further studied.

4.6 Summary of estimated costs using narrative economic analyses

Table 43 summarises the economic impact of the conditions where we have conducted narrative economic analyses. These figures are illustrative and must be interpreted with caution. They are based on very conservative estimates, and take no account of longer term, lifetime costs of obesity, for example. Neither do they capture the broader impact of these conditions, which are likely to have an impact on well-being, life expectancy, and the economy as a whole. Further work is needed to capture these important and extensive consequences.

Table 43: Summary of estimates of economic consequences (undiscounted) of not breastfeeding on three conditions: cognitive outcomes, SIDS, and early years obesity.

Condition	Economic impact
Cognitive outcomes	<p>If the proportion of never breastfeed infants were to decrease by only 1%, the resultant estimated impact would be around 8,000 fewer children who experience cognitive impairment, resulting in about £278 million gains in economic productivity – over the lifetime of each annual cohort of children born.</p> <p>Additional cost savings would accrue from reduction in behavioural problems related to not breastfeeding.</p>
SIDS	A modest increase in exclusive breastfeeding for more than two months could result in avoiding at least three cases of SIDS annually: preventing a monetary loss of approximately £4.7 million annually as well as avoiding the profound consequences for families.
Early years obesity	A modest increase in breastfeeding rates could result in a reduction in childhood obesity by circa 5%. If this was the case, the number of obese young children would fall by approximately 16,300, and annual health-care expenditures would reduce by circa £1.63 million.
Total estimated cost savings from very modest increases in breastfeeding	£278 million gains in economic productivity – over the lifetime of each annual cohort of children born £6.33 million annual cost savings.
Total estimated value of QALYs gained from avoiding SIDS	£3.8 million annually

5 SETTING THE FINDINGS IN CONTEXT

To set the findings of the economic analyses presented in Section 4 in context, three further steps are needed. This section considers:

1. The conditions for which limitations of the evidence base have precluded meaningful quantification of the costs of illness
2. The funding needed to increase support for breastfeeding women in order to achieve prevalence comparable to that used in our economic models. We will present an illustrative case of the costs of implementing these changes in one region, to inform local service commissioners and planners
3. The costs to families and society related to breastfeeding or not.

5.1 Breadth of diseases not included in our economic analyses

Section 4.1.2 lists eight conditions that affect both mothers and children and are related to the mode of infant feeding (referred to as the 'long list'). They include diseases that severely affect quality of life, and ones that persist in adult life, such as coeliac disease, diabetes, asthma, and cardiovascular disease.

The limitations of the evidence base were varied. In many studies, infant feeding was not measured or reported adequately. In others, only proxy outcomes were identified: for example, blood pressure as a marker of cardiovascular risk. Nevertheless, it is essential that the potential economic implications of these diseases are considered; current evidence overall suggests that the risk of several of these chronic conditions such as cardiovascular disease or diabetes, while of complex aetiology, is influenced by mode of infant feeding. Whilst the strength of the association between breastfeeding and these conditions remains uncertain, even a marginal reduction in their incidence as a result of changes in breastfeeding behaviours could result in considerable cost savings. It is likely that broadening the financial impact of these conditions on the broader economy would demonstrate the scale and scope of the

financial burden of these diseases. Further research is nevertheless required to substantiate this statement and measure the scale of this impact.

To illustrate the importance of this research agenda, we identified estimates of the economic burden of three diseases – diabetes, asthma, and cardiovascular disease – on the current health services:

- Diabetes was estimated to cost the health service £2.8 billion in 2007 (National Collaborating Centre for Chronic Conditions and Royal College of Physicians, 2008). Other studies have suggested that it may account for as much as 7–12% of total health expenditures, which equates to close to £10 billion at current levels of NHS funding (National Collaborating Centre for Chronic Conditions and Royal College of Physicians, 2008).
- Costs of cardiovascular disease to the NHS have been estimated at around £14 billion per annum, with a total cost to the economy in excess of £30 billion (BHF)
- Health care costs related to asthma have been estimated as being in excess of £2.3 billion per annum in 2001 figures (Asthma UK)

We cannot estimate with any precision the potential savings associated with increasing breastfeeding prevalence, but even a marginal reduction in the incidence of these conditions brought about by a change in infant feeding behaviours could significantly exceed the financial impacts estimated in Section 4. The quantitative economic findings we have reported provide only a partial perspective on the scale of the costs associated with not breastfeeding; they are likely to represent only a fraction of the total costs incurred. Addressing the economic impacts associated with the chronic conditions listed in Section 4.1.2 therefore provides an important research agenda.

Figure 7 below is an illustrative, diagrammatic representation of this, showing that the costs presented here are likely to be a small sub-set of the real costs of disease and developmental deficit due to low rates of breastfeeding. Note that the darkening shades represent increasing levels of uncertainty about the relationship to breastfeeding and therefore the associated costs.

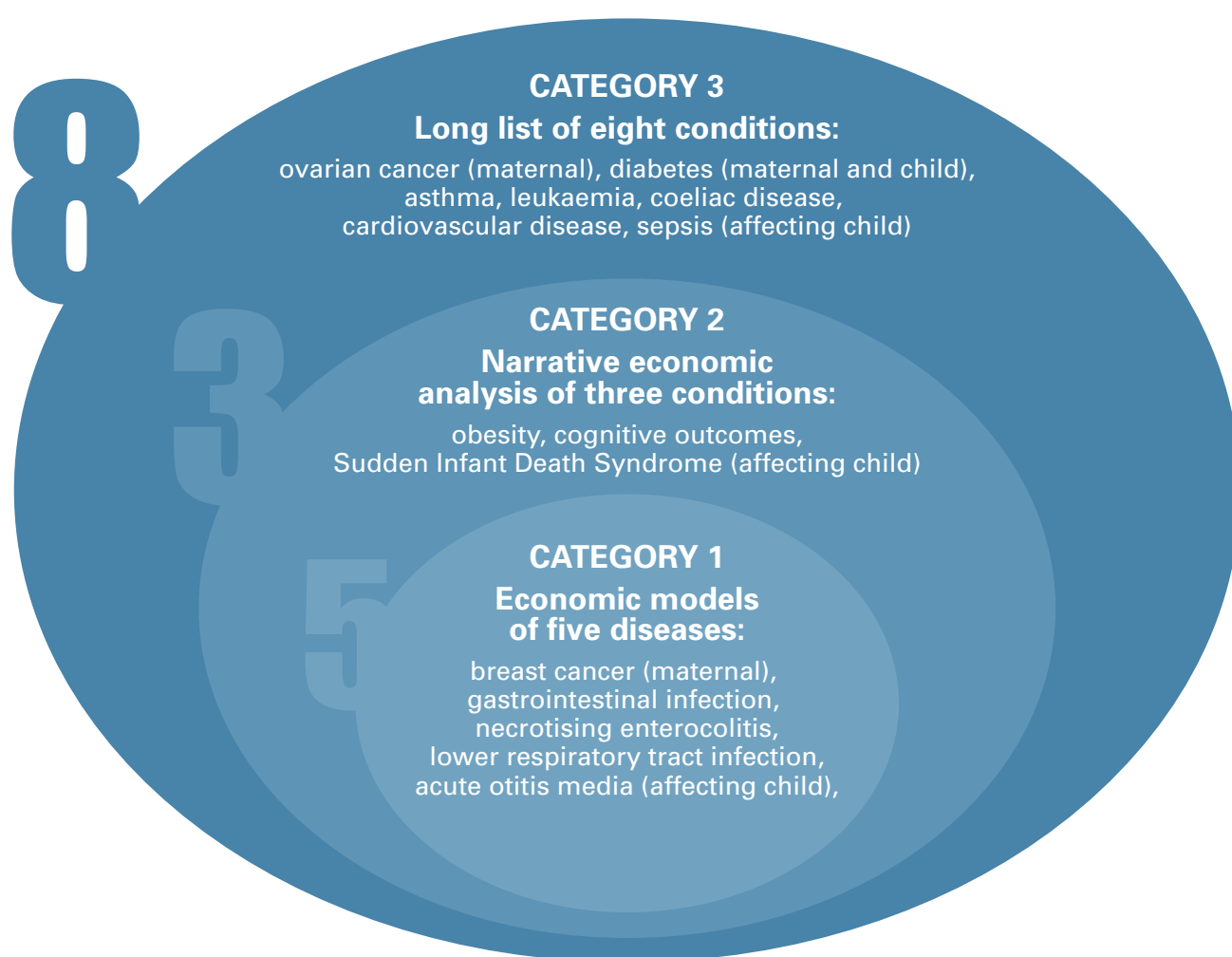


Figure 7: Diagrammatic representation of the costs resulting from disease and developmental deficit resulting from low rates of breastfeeding in the UK (illustrative, not representative). Conceptually the costs estimated in section 4 are likely to be a small sub-set of the real NHS costs associated with low breastfeeding rates.

5.2 Costs of increasing breastfeeding prevalence

In order to increase the prevalence of breastfeeding in the UK, it will be necessary both to increase the number of women initiating breastfeeding and to extend the duration of breastfeeding. Fully understanding the net economic impact of increasing breastfeeding prevalence requires that potential cost savings are balanced against the costs of measures to promote, protect and support breastfeeding.

Implementing change to promote breastfeeding and support women to breastfeed has been recommended for some years in NICE guidance (National Institute for Health and Clinical Excellence, 2008 updated 2011) and in strategy documents in Scotland (The Scottish Government, 2011), Northern Ireland (Gossrau-Breen et al, 2010), and Wales (National Assembly for Wales, 2001). Further developing such promotion and support would be an appropriate response to the inclusion of breastfeeding initiation and duration at 6–8 weeks in the Commissioning Outcomes Framework for the NHS in England (Department of Health, 2012). However, the resources required by the NHS and related sectors to achieve such increases have to be identified. We recognise that health services and public services as a whole are working under severe resource constraints, and budgets have little or no capacity to respond to additional spending requirements. We have therefore considered the actions that would be most likely to be both effective and efficient in creating the changes needed to enable women to breastfeed.

Identifying an effective programme of measures

We sought to identify an appropriate package of measures that would tackle the multifaceted barriers to breastfeeding, and that could be locally commissioned at a time of substantive organisational change in the NHS and severe resource constraints. We wished to identify a package that would have the potential to increase the rates to the levels assumed in our policy scenarios; at the least, to support 21% of women to breastfeed exclusively at four months, for 50% of babies to be breastfed at discharge from neonatal units; and for 16% of women to breastfeed for 7–18 months in their lifetime.

First, we considered evidence on effective interventions, and national strategies and guidance. A series of systematic and critical reviews has identified key interventions that are effective in raising rates of initiation, duration, and/or exclusivity – for example Dyson et al (2008), Dyson et al (2006), Renfrew et al (2012). A common and important finding has been that overcoming the challenges facing women who consider breastfeeding requires the implementation not of single interventions, but of a multifaceted package of interventions tailored to the needs of the local population. These must together address the clinical, educational, and societal barriers to breastfeeding. This evidence base has informed the UNICEF UK Baby Friendly Initiative community programme (UNICEF UK Baby Friendly Initiative, 2008 revised), NICE guidance (National Institute for Health and Clinical Excellence, 2006a; National Institute for Health and Clinical Excellence, 2008 updated 2011), and strategy documents in Scotland (The Scottish Government, 2011; Scottish Parliament, 2005) and Northern Ireland (Northern Ireland Breastfeeding Strategy Group, 1999). Priority recommendations common across the four UK countries for care offered in hospital and community settings include:

- Implementation of a structured programme that encourages breastfeeding in NHS Trusts, using the UNICEF UK Baby Friendly Initiative accreditation as a minimum standard.
- Training of health professionals to protect and promote breastfeeding and to support breastfeeding women.
- Implementation of a multifaceted programme of interventions across different settings, including staff training, peer support, and activities to raise awareness and overcome barriers to breastfeeding; ensuring peer supporters are part of a multidisciplinary team and receive appropriate training.
- Identification of a health professional with responsibility for breastfeeding policy at local level.

One locality has agreed a relevant comprehensive

programme. Lancashire Children's Trust have agreed and are implementing a region-wide programme for commissioning effective, local infant feeding support services (Appendix 14). This programme was based on key, evidence-based interventions identified from the critical and systematic reviews described above, and from a national Evidence into Practice exercise involving several hundred practitioners and user representatives (Dyson et al, 2010b). These were further developed in a consultation exercise involving academics, health professionals and service user representatives, undertaken in 2011 to identify the top 10 interventions to promote and support breastfeeding in times of severe resource constraints (Entwistle et al 2011, Lancashire Children's Trust: Appendix 14). A list of 10 interventions was finally agreed following widespread electronic consultation. The priorities identified go beyond current national priority recommendations. Participants agreed that the interventions should be seen as a whole;

selecting only one or two of the interventions was considered likely to be less effective than implementing all elements together. Components of this programme have since been examined in practice (Thomson et al, 2012; Dykes et al, 2011).

We have used the Lancashire programme as a basis for illustrating the cost of an evidence-based, multifaceted intervention programme at local level; we have also produced Lancashire-specific versions of our cost of illness models to see how the illustrative estimates of costs of interventions and the costs of disease compare at the level of one region.

The components of the Lancashire Children's Trust programme are shown in Box 1; those shown in bold are currently priority policy recommendations across the UK.

Box 1: Components of the Lancashire Children's Trust programme

1. **Maternity services in both the hospital and community setting to gain the World Health Organization/UNICEF Baby Friendly Initiative accreditation 'Ten steps to successful breastfeeding' and the 'Seven Point Plan for sustaining breastfeeding in the community'.**
2. **Peer, 'mother to mother' support programmes to be implemented alongside health professional care.**
3. **Universities to gain UNICEF UK Baby Friendly Initiative accreditation in pre-registration midwifery and post-registration health visiting programmes.**
4. Neonatal networks trained to implement effective breastfeeding support for sick and premature babies.
5. Provision of 'donor' breastmilk where a mother is unable to breastfeed her baby and including the most vulnerable such as premature babies, those in neonatal units and babies age less than 6 months who are to be adopted.
6. A robust and critical support service to filter harmful advertising and marketing of formula milks.
7. **Strategic leadership, local and regional, to implement evidence-based policy and practice, including those areas that impact on infant feeding practice such as where babies sleep.**
8. 'Breastfeeding welcome' employer, community and public spaces.
9. Schools programmes that promote breastfeeding.
10. Services that support women who are artificially feeding their babies to minimise the risks.

5.3 Illustrative costing of the Lancashire programme

Using information supplied by staff of Lancashire Children's Trust, we have illustrated the costs of the implementing this programme across Lancashire, in order to demonstrate how it could be adapted by other parts of the country (see Table 45 on page 77). When considering implementation of a programme such as this in other localities, it should be noted that costs will vary according to local characteristics; factors such as the geographic and population base, socio-economic composition, ethnic diversity, existing service provision, and current rates of breastfeeding may all modify costs.

5.3.1 Profile of Lancashire region

Lancashire is a region in the north-west of England. It includes the 12-district Lancashire County area and the two unitary authorities of Blackburn-with-Darwen and Blackpool, covering over 3,000 square kilometres. Lancashire region has a population of almost 1.5 million people, with around 13,829 births annually (13,785 after adjusting for neonatal mortality). It is a large geographical area, retaining a strong economic base underpinned by long urban and industrial traditions.

Lancashire experiences a greater share of deprivation than the national average, and health outcomes are relatively poor compared to other areas of the country. The social and economic diversity evident in the county is reflected in health inequalities that persist across local areas. People in the most deprived parts of Lancashire experience

significantly poorer health than those in the most affluent parts of both Lancashire and the rest of the UK. The 2010 Indices of Deprivation highlight a number of local authorities and smaller areas of the county that encounter significant problems. Six authorities are ranked in the bottom 50 of the 326 local authorities in England. The percentage of the 940 lower super output areas (LSOAs) in the 14-authority Lancashire area falling into the 10% most deprived in the country increased from 16% in 2007 to 17.4% in 2010. Although Lancashire has a lower representation of minority ethnic groups than the UK as a whole (91% of the population is classed as white British, Irish or other), there are localities in the region with higher representation: for example, significant Indian, Pakistani and Bangladeshi populations are located in Blackburn-with-Darwen (20%), Pendle (14%), and Preston (11%).

Lancashire is a relevant region to act as a model for this work, as it has significant challenges of deprivation and of geography – with a population that lives in both urban and rural areas. Breastfeeding prevalence is relatively low (see Table 44), reflecting the population base, but there is commitment among the public health community to increase the breastfeeding rates.

Table 44: Breastfeeding rates (%) for Lancashire PCTs 2009–10 (source: DH and ChiMat websites) compared with national rates (from Infant Feeding Surveys: Bolling et al, 2007; NHS Information Centre, 2011) (Bolling et al, 2007, Information Centre for Health and Social Care, 2011)).

Primary Care Trusts (PCTs)	Initiation of breastfeeding	Any breastfeeding at 6–8 weeks
Blackburn	71	36
Blackpool	60	22
Central Lancashire	66	32
East Lancashire	67	39
North Lancashire	68	35
England	83	50
Scotland	74	44
Wales	71	37
N Ireland	64	32

5.3.2 Assumptions made in the illustrative estimate of costs of the programme

The following assumptions have been made to guide the costing of the intervention programme:

- All costs have been calculated on the basis of the Lancashire population and services.
- The perspective of this costing is the implementation of policy to promote and protect breastfeeding and to support breastfeeding women beyond the existing position; assuming that the current positive policy position is maintained and developed.
- We have assumed that measures identified as priorities in national guidance and strategies (as described above) have either been implemented already, or that plans should be in place. This perspective is strengthened by the inclusion of breastfeeding initiation and duration at 6–8 weeks as priorities in the Commissioning Outcomes Framework for England (National Institute for Health and Clinical Excellence, 2012). These activities are assumed to be already funded or included in future plans and are not considered as incremental costs. We recognise that some localities have yet to put such services in place; while in others, services are already embedded in the system.
- Costings have taken into account interaction between elements of the programme; for example, the infant feeding coordinators and strategic leadership identified in point 7 would support several specific interventions. The programme should therefore be viewed as a whole; separating out specific elements would require recalculation of the costs.
- We have not included costs to other related sectors (for example, education) as part of this package. In practice, these costs would be shared between different sectors and would not accrue to the health service.
- Details of the programme components and the calculations of all costs are given in Appendix 15. The Baby Friendly Initiative costs are given in Appendix 17.

5.3.3 Illustrative estimate of the costs of the increasing breastfeeding rates programme for Lancashire

Table 45: Total incremental costs of the 10-point programme for Lancashire. Activities recommended as NICE priorities have not been costed (Full details are given in Appendix 15).

Promotion and support activity	Cost	Whether any additional cost, one-off cost, or recurring
UNICEF Baby Friendly Initiative accreditation as minimum standard for maternity units and PCTs	Priority national recommendation (See Appendix 17 on Baby Friendly Initiative costs)	Assumption already in budget (Note: Baby Friendly Initiative implementation is an ongoing service cost - see Appendix 17.)
UNICEF Baby Friendly Initiative accreditation of universities	Education of health professionals is priority national recommendation (See Appendix 17 on Baby Friendly Initiative costs)	Assumption already in budget (Note: Baby Friendly Initiative implementation is an ongoing service cost - see Appendix 17.)
Peer support service	Priority national recommendation	Assumption already in budget.
Neonatal networks training	£117,000	One-off
Provision of donor milk	£13,300	Recurring
Support service to filter harmful advertising	£57,000	Recurring
Strategic leadership	£259,000: 50% cost to reflect component that is priority national recommendation (that is, local leadership)	Recurring
Breastfeeding-welcome employers and public spaces	Not included in this costing – outside of the health sector	
Services to support women who are formula feeding	Included in current services	No additional cost
Schools programme	Not included in this costing: outside of the health sector	One-off cost: mainly to the education sector
Total one-off costs	£117,000	
Total recurring costs	£329,300	
Total Year 1 costs	£446,300	

5.4 Issues to consider

5.4.1 Implementing the programme of change

A multifaceted package is needed to address the complex challenges of enabling women to breastfeed (Dyson et al, 2006), so it is likely that the measures outlined here are complementary and the costs are interrelated. Individual activities may be less cost-effective if not introduced in a coherent programme of planned change; for example, the strategic leadership component will support and enable most of the other components.

5.4.2 Further reductions in costs over time

It is possible that as members of staff become more skilled, and as newly qualifying students will not require additional training, the requirement for Trust-based leadership may decrease. Further, the number of women experiencing significant problems with breastfeeding may decline with increasing staff skills, bringing direct savings in the time of community and hospital staff and allowing them to spend more time on other aspects of care, and also directly for the women and their families. However, it is also possible that ongoing education and training is needed to ensure consistent standards and deal with staff turnover.

In the broader context, if more women breastfed, and continued to breastfeed for as long as they wish, the socio-cultural barriers to breastfeeding would be likely to diminish. Increasing awareness and respect of protection recently put in place to protect women from discrimination when they are breastfeeding in a public place (H.M. Government, 2010; Scottish Parliament, 2005), together with effective monitoring and enforcement of this legislation, is likely to improve the situation for many women.

5.4.3 Considering the costs in context: Lancashire-specific economic analysis

To set the Lancashire programme costs in context, we calculated Lancashire-specific cost of illness models, based on the population of the region and using Lancashire data where possible.

Table 46 shows the upper, mid and lower estimates of potential savings that might be accrued from the five disease models. For full details, see Appendix 16.



Table 46: Estimated cost savings from Lancashire-specific models, for all policy scenarios (see Appendix 16 for details).

Disease or condition	Potential cost savings: lower estimate from least optimistic increases in breastfeeding rates	Potential cost savings: mid estimate from mid-range increases in breastfeeding rates	Potential cost savings: upper estimate from most optimistic increases in breastfeeding rates
Gastroenteritis in infants (per year)	£15,341	£89,687	£136,891
Lower respiratory tract infection in infants (per year)	£24,898	£145,558	£222,168
AOM in infants (per year)	£2,296	£13,425	£20,491
NEC in babies in neonatal units (per year)	£40,132	£107,018	£173,904
Total estimated savings from costs of treatment of acute diseases in children (per year)	£82,667	£355,688	£553,454
Breast cancer cases avoided of annual cohort of 5,504 first-time mothers (over lifetime)	11	15	20
Breast cancer treatment costs saved of annual cohort of 5,504 first-time mothers (over lifetime)	£268,982	£371,317	£487,580
Breast cancer: value of QALYs saved of annual cohort of 5,504 first time mothers (over lifetime)	£130,219	£179,761	£236,046
Breast cancer: incremental benefit of annual cohort of first-time mothers (over lifetime)	£399,201	£551,078	£723,626

These estimates suggest that using an evidence-based and proactive policy option likely to increase breastfeeding rates is expected to generate savings on treatment costs of acute infant diseases of between around £83,000 and £550,000 per annum. Added to this are the treatment costs of breast cancer, which accrue over the lifetime of each annual cohort of first-time mothers; these costs are estimated to be around £270,000 to £490,000. Breast cancer-related QALYs saved have been valued at between around £130,000 and £236,000 over the

lifetime of each annual cohort of first-time mothers. These costs compare to an initial first year investment by the health service of around £446,300 for additional services, in addition to service provision currently recommended as priorities in national guidance. Recurring costs would be around £329,300 annually. A significant proportion of the incremental investment in services that is required to promote breastfeeding can therefore be offset in the short term. However, there are two important points that should be taken into account.

First, the projected savings relate only to those conditions that are considered in our cost of illness models, and furthermore relate only to the savings to the health service; we have only valued QALYs related to breast cancer, not for other conditions related to the infant. Further, inclusion of the health impacts of breastfeeding on those conditions considered in the narrative analyses (SIDS, cognitive outcomes and early years obesity) would significantly alter this position. We have not included quantitative calculations on these as a result of uncertainty around the scale of the effect, but it is evident that it is likely to be considerable. We have also not considered the long list of eight, mainly chronic, outcomes where further evidence is needed to estimate the scale of the effect of *not* breastfeeding. If breastfeeding were to have even a modest impact on these other conditions, the return on investment in breastfeeding services would look very favourable and would increase year on year. The time taken to realise the investment will depend on the rate at which breastfeeding initiation, duration and exclusivity increase, which in turn will depend both on factors in the local population and on the extent and quality of services to support breastfeeding women. The diseases studied here have shown a dose-response effect that means that even a small increase is likely to result in some savings.

Second, it is important to recognise that the savings resulting from disease reduction are unlikely to be short-term cash releasing savings: they may be accrued over a period of time (for example, for breast cancer). The savings represent reductions in resource use. In practice, this could mean a mix of, for example, lowered expenditure on pharmaceuticals for these conditions, and reducing staff time spent caring for people with these conditions. These may or may not result in cash savings, depending on the choices of local commissioners. Commissioners need to recognise that incremental investment will be required in the short term, but that both cash releasing and efficiency gains should be made over time.

In 2007, NICE estimated that it would take 15 years before a return on investment would be seen from implementing the UNICEF UK Baby Friendly Initiative (National Institute for Health and Clinical Excellence, 2006b). In their calculations, they examined the costs saved by reductions in AOM, gastrointestinal infection, and asthma for infants. The analyses presented in this report suggest that investment in

breastfeeding is likely to lead to a positive net benefit within a shorter period. Our analyses indicate that a significant proportion of the incremental investment can be offset in the shorter term, suggesting that the time required for a positive return on investment is likely to be closer to one year than to 15.

5.5 Broader costs to families and society of not breastfeeding; the economic consequences of infant feeding policy

Our cost of illness analyses have focused on the costs to the health services, but the economic consequences of infant feeding policy are also of relevance to society and the economy, government and the community, the family, the mother, and the baby/child (Smith, 1999; Rippeyoung and Noonan, 2012); see Appendix 5 for related papers and discussion.

The consequence of the current challenging environment for breastfeeding women (Section 1.4) is that a policy decision not to promote and support breastfeeding is likely to result in continued low breastfeeding prevalence and a high incidence of breastfeeding problems (such as weight faltering, engorgement, and mastitis) that can be prevented by provision of skilled support. Wider economic considerations might include, for example, the costs to society (for example, the environmental costs of producing formula, bottles and teats; and flexible working conditions versus time off work to care for sick children); government and community (for example, provision of breastfeeding-friendly public spaces versus costs to education sector of cognitive deficit); the family (for example, time needed to support breastfeeding mother versus costs of formula, bottles and teats, time off for caring for sick child), the mother herself (for example, less time spent feeding baby if she has others to help versus more time off work to care for sick child), and the baby her/himself. This forms an important research agenda for future economic research.

6 SUMMARY AND DISCUSSION

6.1 Strengths and limitations of the study

In this study, our multidisciplinary research team has brought together knowledge and understanding of health economics, statistics and epidemiology, systematic reviewing, infant feeding, user perspectives, the clinical understanding of disease, and knowledge of health policy, to examine the potential costs to the health service of the current high rates of artificial feeding in the UK population.

The study took place over several stages, each of which needed debate and discussion among the whole research team. The work was conducted using structured and transparent processes, and clear criteria. Each outcome was considered separately, as the evidence and the scale of impact was different for each one. We focused on evidence that was relevant to the UK, and we developed policy scenarios that we considered to be achievable in UK settings to calculate the potential for saving costs by increasing the rates of breastfeeding. There is evidence from other countries to demonstrate that our proposed policy scenarios are realistic and achievable. Continuing to increase the duration and exclusivity of breastfeeding beyond our proposed policy scenarios would result in substantive additional gains.

6.1.1 The evidence base

We identified 25 reviews and UK studies that informed detailed economic modelling for five outcomes (breast cancer in mothers, and gastrointestinal infection, lower respiratory tract disease, AOM, and NEC in children) and a narrative analysis for three (cognitive outcomes, SIDS, and early years obesity).

We examined not only the epidemiological evidence (Section 4.3), but also the biological plausibility (Appendix 7) of these eight outcomes being related to infant feeding. There is good scientific evidence to confirm the likelihood of these conditions being directly related to *not* breastfeeding.

We also identified a further long list of eight disease outcomes of complex aetiology where there is reasonably good evidence that *not* breastfeeding increases their prevalence. Together, these eight diseases constitute a significant cost burden for the NHS. They include ovarian cancer in the mother, and diabetes in the mother and child, and diseases in the child including cardiovascular disease and asthma. Examining further the economic implications of these conditions should inform an important research agenda.

We found that the quality of studies and reviews has improved somewhat in recent years. However, even the good quality studies we identified had significant methodological problems. Problems we encountered included:

- Randomised controlled trials are very challenging in this field, and we were mainly reliant on cohort or case-control studies. Many of these did not, however, adequately control for confounding factors
- Studies used varying definitions of diseases
- The low rates of breastfeeding, and especially of exclusive breastfeeding, in the UK and many other industrialised countries. Few babies and mothers experience prolonged, exclusive breastfeeding so that the burden of disease associated with not breastfeeding can rarely be measured and is probably underestimated
- Importantly, the measurement of exposure (the duration and exclusivity of breastfeeding and the nature of breastmilk substitutes used) was invariably weak. Again, this is most likely to underestimate the burden of disease associated with not breastfeeding
- There were limited data available on the rates and costs of disease related to infant feeding.

Robust, systematic, conservative, UK-specific approach

To maximise the use of the evidence and to manage its limitations, we developed a robust, systematic and transparent approach that:

- took account of the limitations of the evidence base
- was tailored to the specific circumstances of each disease and condition
- used data relevant to the UK
- was careful not to overestimate or underestimate the burden of disease or the costs resulting from artificial feeding. To avoid the risk of over estimation of costs however, we consistently erred on the side of conservative assumptions when making methodological decisions
- considered realistic policy options in the light of evidence of effectiveness of interventions.

As a consequence of our approach, it is likely that our economic models and narrative analyses underestimate the economic consequences of not breastfeeding in the UK. Further, we did not include calculations of the QALYs related to infant diseases. **As so many other outcomes do not have evidence in the form required for economic modelling and we have only included costs to the health sector, these estimates are likely to be a minimum estimate of the economic consequences of the current low rates of breastfeeding in the UK.** The scale of our estimates is broadly in line with the analyses conducted by others in developed countries. In the USA, for example, it is estimated that US\$3.35 billion in treatment costs could be saved by increasing current exclusive breastfeeding rates at 6 months to 90% (Bartick & Reinhold, 2010). In Australia, others have estimated that AUS\$9 million in treatment costs could be saved by increasing the exclusive breastfeeding rates at 3 months to 80% (Drane, 1997). In the Netherlands, it is estimated that a saving of €250 per newborn per year could be achieved by increasing exclusive breastfeeding rates at 6+ months to 100% (Buchner et al, 2008). In Italy, the difference in treatment costs between

‘fully’ breastfed (exclusively or predominantly for 3 months) and ‘non-fully’ breastfed (complementary feeding or no breastfeeding) children is estimated at €160 per infant per year (Cattaneo et al, 2006). We acknowledge that a meaningful comparison of our findings with these studies on the ‘scale’ of such savings is not possible, as the reported cost-savings in the literature refer to different breastfeeding rates and scenarios in different countries, the number of health outcomes included in the studies differs significantly and the definitions of breastfeeding vary. Nevertheless, our report confirms the general findings of earlier studies from outside the UK that increased breastfeeding is associated with potential cost savings for the health sector.

6.2 The costs of disease and developmental deficit

Our extensive review identified the wide-ranging and costly impact of ‘not breastfeeding’ to child and adult health in the UK. Diseases and conditions that could be prevented at least in part by raising breastfeeding rates affect mothers and infants who are in special care as well as those who are born healthy at term. They also include acute and chronic outcomes that affect short, medium- and long-term health and well-being. Artificial feeding affects public health in many different ways, with costs to and implications for several different sectors.

Quantitative economic analyses: robust costings

The robust, quantitative economic models, using high quality evidence, found that by assuming achievable increases in the proportion of women breastfeeding, and using our mid-range assumptions (45% of women exclusively breastfeeding at four months, and 75% of babies breastfed at discharge from neonatal units), **every year** there would be approximately:

- 3,285 fewer gastrointestinal infection-related hospital admissions and 10,637 fewer GP consultations, with over £3.6 million saved in treatment costs annually
- 5,916 fewer lower respiratory tract infection-related hospital admissions and 22,248 fewer GP consultations, with around £6.7 million saved in treatment costs annually

- 21,045 fewer AOM-related GP consultations, with over £750,000 saved in treatment costs annually
- 361 fewer cases of NEC, with over £6 million saved in treatment costs annually.

In total, over £17 million could be gained annually by avoiding the costs of treating the four acute diseases in infants.

Increasing breastfeeding prevalence further would result in even greater cost savings; the more optimistic policy scenarios modelled (65% of women exclusively breastfeeding at four months, and 100% of babies breastfed at discharge from neonatal units) showed potential savings from the four acute infant diseases of around £27 million.

In addition, in relation to breast cancer and using our mid-range policy scenario (half of mothers who currently do not breastfeed were to breastfeed for up to 18 months in their lifetime), we calculated that the following would be saved over the lifetime of an annual cohort of around 313,000 first-time mothers, the current number of UK women giving birth to their first baby each year:

- 865 fewer breast cancer cases
- with cost savings to the health service of over £21 million
- 512 breast cancer-related QALYs would be gained, equating to a value of over £10 million
- resulting in an incremental benefit over the lifetime of each annual cohort of first time mothers of over £41 million.

The most optimistic policy scenario modelled for breast cancer (32% of women breastfeeding for over 18 months in their lifetime) would result in an incremental benefit over the lifetime of each annual cohort of over £41 million.

Even the most optimistic policy scenarios were set at realistic levels, taking into account rates achieved in other European countries – for example, Sveriges officiella statistik och Socialstyrelsen (2009), Lande et

al (2003) – as well as the marked increase in initiation rates observed in the UK in the past 25 years. Greater economic gains would be made were rates to exceed these levels.

6.2.1 Narrative economic analyses: estimates of broad magnitude

Our narrative analyses of three conditions where modelling was not possible, and where costs reached widely to sectors outside of the health service, found that:

- decreasing the never breastfed rate by 1% could result in over £278 million gains in economic productivity over the lifetime of each annual birth cohort from improved cognitive outcomes
- a very modest increase in the rates of exclusive breastfeeding could result in the avoidance of at least three cases of SIDS annually, preventing an annual monetary loss of around £4.7 million and a loss of £1.3 million annually in QALYs, as well as avoiding the profound consequences for families
- increasing breastfeeding rates to a level that reduced the rates of early years obesity by as little as 5%, would result in reducing annual health care expenditures by more than £1.6 million.

The nature of these conditions, and the limitations of the current evidence base, mean that the scale and scope of the economic impact is difficult to measure with precision. It is evident that it is likely to be very wide ranging, and very costly, and the work on these topics informs an important research agenda.

6.2.2 Other diseases where evidence is needed

We identified a long list of eight further diseases and conditions where evidence of an adverse effect of not breastfeeding exists, but where the evidence did not meet our strict criteria for the cost of illness analysis (Table 7). Some of the conditions on this long list are among the most expensive to the NHS. They include ovarian cancer and Type 2 diabetes in the mother, and asthma, cardiovascular disease, coeliac disease, leukaemia, sepsis, and diabetes in the child. Reducing these conditions by even 1–2% would have a major economic impact.

A further 173 systematic reviews or relevant studies examining 45 diseases and conditions affecting both mothers and children were identified. We considered the evidence available to be too limited to comment on. Further research on these may help to clarify the extent of any relationship with infant feeding.

Investing in enabling women to breastfeed

Increasing the prevalence of breastfeeding will need investment in services. Using one English region as an example, we illustrated the cost of implementing a multifaceted, evidence-based regional programme that would build on priority national recommendations. Within any UK locality of similar size and population base, such a programme would cost around **£446,300** in its first year, with a recurring annual cost of around **£329,300**. These costs could be set against our mid-range estimate of potential short-term cost savings per year in this region resulting from the treatment costs of the four acute infant diseases of around £355,000. There would be further cost savings from the treatment of breast cancer, which would accrue over the lifetime of each annual cohort of mothers; our mid-range estimate of this cost is around £370,000. Breast cancer QALYs saved over their lifetime would be valued around £180,000. Although quantitative calculations for the three conditions examined in our narrative analyses cannot be included as a result of uncertainty around the scale of the economic impact, the cost burden of these conditions would add considerably to this scenario.

Our analyses indicate that a significant proportion of the incremental investment in services required to promote breastfeeding can therefore be offset in the short term, and suggest that the time required to show a positive return on investment is likely to be closer to one year than the 15 years estimated by NICE (2007).

Investing in public health interventions can be seen as challenging at a time when funds are scarce. However, while potential financial savings accrue in the future, this report has also shown that **the potential savings from breastfeeding support are additionally likely to be realised over a much shorter time horizon**. At a time when health-care investments need to show a near-term return on investment, this is an important consideration.

It is also important to invest in interventions that have been shown to be effective, and not to use resources on ineffective or short-term initiatives. Effective interventions have been identified in NICE guidance (NICE, 2008 updated 2011) and in systematic reviews (for example, Dyson et al, 2008; Renfrew et al, 2012; Spiby et al, 2009; Beake et al, 2012).

6.3 Wider economic implications

We have considered the potential economic implications of not raising the breastfeeding rates to the UK economy more broadly. These are likely to include adverse impacts at the levels of wider society, families, and for women and babies.

Successive national Infant Feeding Surveys show that over 90% of women who stop breastfeeding in the first six weeks, and 75% who stop in the first nine months, would have liked to breastfeed for longer. This indicates that the lack of support for women and the lack of protection for breastfeeding in society leads to disappointment and distress. This disappointment can result in a backlash against breastfeeding, and blaming of those who promote breastfeeding and work to support breastfeeding women. It can promote a contentious discourse even among health professionals, academics and journalists as well as the wider public (for example, Martyn, 2011; Dyson et al, 2010a; Henderson et al, 2000; Lee, 2007, and so on), and risks perpetuating the costs of not breastfeeding to the wider society as well as to the health services. Conversely, it indicates that women want to breastfeed and want to breastfeed for longer, and that active policy support to enable women to breastfeed and to prevent problems has the potential to break through the inter-generational barriers and entrenched patterns of inequality.

6.4 Policy environment

Breastfeeding initiation rates in the UK have risen steadily over the past decade, from 62% in 2000 to 81% in 2010. This has been in the context of a strong policy environment, nationally and internationally, and includes the WHO Global Strategy on Infant and Young Child Feeding (WHO, 2003), and positive policy developments and NHS guidance to promote breastfeeding across all four countries in the UK (UNICEF UK Baby Friendly Initiative, 2001; Department of Health, 2007, National Institute for Health and Clinical Excellence, 2008 updated 2011; Department of Health, 2009; The Scottish Government, 2011; Department of Health, 1995; Northern Ireland Breastfeeding Strategy Group, 1999; SACN/RCPCH Expert Group on Growth Standards, 2007).

However, early discontinuation and low rates of exclusive breastfeeding persist. Around 40% of women stop breastfeeding in the first few weeks after birth (Bolling et al, 2007; Child and Maternal Health Observatory, 2012). It appears that the UK environment does not yet enable women to continue to breastfeed, so that choice remains out of reach for many women. As a result, women encounter not only problems with breastfeeding, but the accompanying distress and guilt of not being able to continue with their chosen method of feeding their babies. This is likely to have an impact on the critically important, formative days and weeks of the child's life and the development of the family. Figure 8 illustrates the linked factors that result from an environment in which women are not enabled – with full support from all relevant sectors – to continue to breastfeed their baby for as long as they wish.

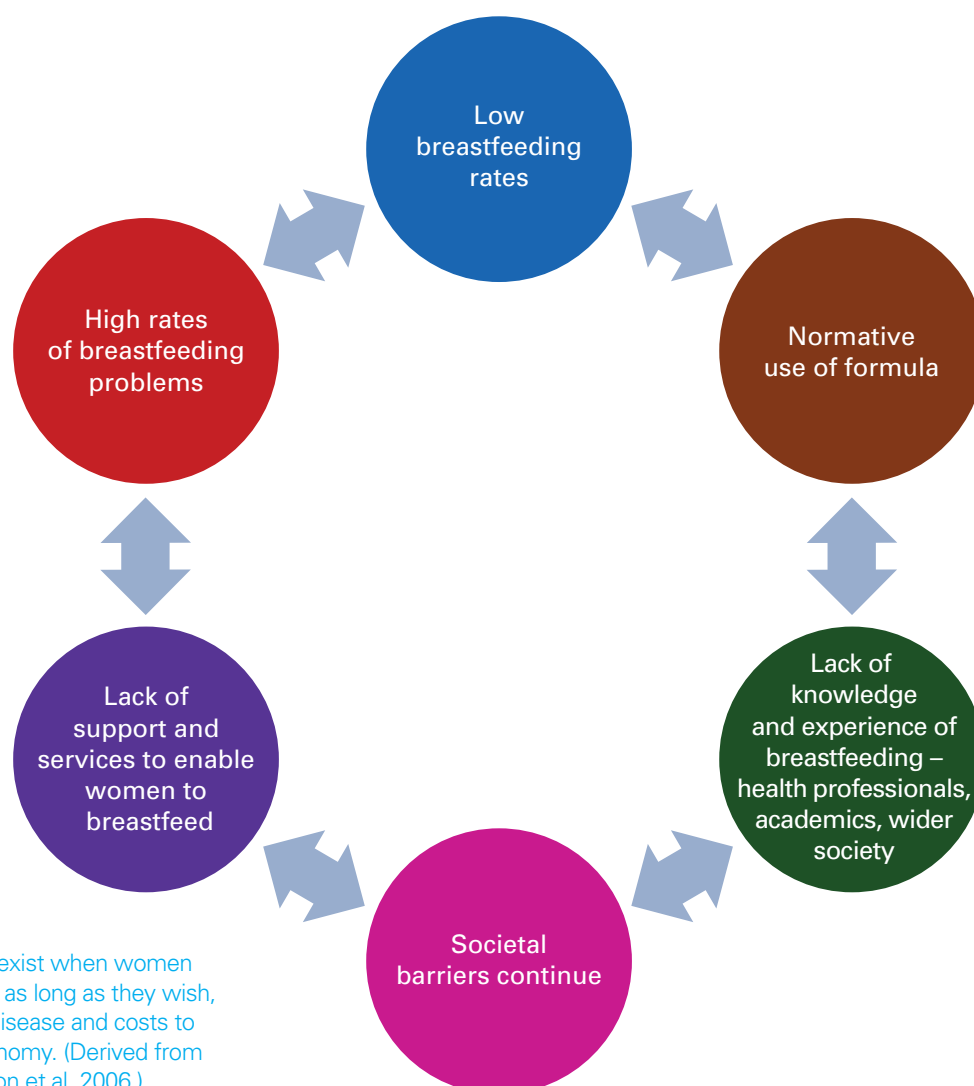


Figure 8: The linked factors that exist when women are not enabled to breastfeed for as long as they wish, resulting in avoidable burden of disease and costs to the health service and wider economy. (Derived from findings of studies including Dyson et al, 2006.)

Breastfeeding promotion needs to take place in an environment where women are informed and supported; and where breastfeeding problems can be prevented or, where they do occur, can be easily and quickly resolved. This will require the implementation of a multifaceted programme of interventions. Our findings may reassure policymakers, service planners and commissioners that such interventions are likely to result in a rapid return on investment.

6.5 Research agenda

There is an important research agenda to examine further the extent of the public health burden related to infant feeding patterns in the UK. This could include:

- Detailed studies examining the complex relationships between infant feeding and the economic and health consequences of those conditions for which we were able only to conduct narrative analyses. These were cognitive outcomes, SIDS, and early years obesity.
- Further examination of the relative contribution of infant feeding to causation of chronic disease. We identified a long list of eight conditions of multifactorial aetiology where more information is needed to quantify the specific contribution of infant feeding.
- Our systematic literature search identified a further 45 conditions for which limited data exist. This offers further scope for research.
- Long-term prospective cohort studies should be established specifically to examine these issues. These should adopt accurate measurement of exposure to feeding modalities.
- Robust cost-effectiveness analyses are needed that compare the costs of interventions, and the best mix of interventions, with the potential benefits accrued.
- Studies of the costs and benefits at a household level for varying infant feeding practices would inform the economic issues for families.
- Research is needed to examine why both the public perception of breastfeeding and professional discourse is so contentious in the UK. Such insight could assist more effective promotion of breastfeeding and support for breastfeeding women.
- Studies of infant feeding require specific methodological approaches. In-depth discussions of relevant research methods exist and should inform future research design (for example, Renfrew et al, 2007; Labbok and Coffin, 1997).

7 CONCLUSIONS AND RECOMMENDATIONS

Enabling women to breastfeed is a health issue where the interests of the mother, baby and the health services all align.

Our extensive review has identified the wide-ranging impact of not breastfeeding on child and adult health in the UK. Artificial feeding affects public health in many different ways, with costs to and implications for several different sectors.

The inclusion of breastfeeding in the national strategies across the UK countries, and most recently in the Commissioning Outcomes Framework for England (National Institute for Health and Clinical Excellence, 2012) is a key opportunity to improve population health and to tackle health inequalities. However, promotion of breastfeeding alone is not enough. Greater investment in support for women who have chosen to breastfeed is essential. Effective, proactive, accessible, high quality services are needed. Such services would minimise problems and intervene swiftly and appropriately when needed, thereby enabling women to sustain breastfeeding, and improving the health of mothers and babies. They would save money both for the health services and the broader economy, and for families. This study should reassure policymakers, service planners and commissioners that a rapid return on investment is realistic and feasible.

More research is needed to extend our knowledge of the impact of infant feeding on health. This would improve the modelling and analysis we have undertaken, and permit accurate costing of three conditions in which we found data insufficient for modelling. Our quantitative analyses were limited by the lack of adequate data to the examination of four acute diseases in infants and breast cancer in mothers. We have identified a priority long list of eight further conditions where data exist, but not yet in a form that permits economic modelling. These include several chronic disease outcomes. Our inability to model the economic impact of important and expensive chronic diseases reflects a failure by the health and research communities to resolve the long-standing methodological challenges in this field, and to acknowledge its potential in reducing future health costs and improving population health. This is

a symptom of the core, somewhat circular, problem: until adequate data are available, the magnitude of the contribution of low breastfeeding rates to chronic disease cannot be measured or recognised, so the issue remains of low priority. The resultant lack of current systemic support for breastfeeding, together with the ongoing normalisation of artificial feeding, risks perpetuating growing rates of related health problems and the costs of treating them at scale.

There is a need for society to debate infant feeding more widely; its economic consequences, and its role in child health, child development, maternal health, family life and relationships.

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A strong mother-baby relationship is the foundation for a baby's future health and well-being. Breastfeeding supports this loving bond and makes a vital difference to health.

Recognising that the support mothers receive is crucial to successful breastfeeding, the World Health Organization and UNICEF have a joint, worldwide programme – the Baby Friendly Initiative.

For the past 16 years, UNICEF UK has been running the Baby Friendly Initiative in the UK, seeking to improve care around infant feeding in the NHS and reduce health inequalities. The Baby Friendly Initiative is funded through charging for the training and tools that we provide. No donor money to UNICEF was used to fund this research.

